JULY 7, 1958

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Product Engineering

DESIGN edition

McGRAW-HILL MAGAZINE FOR DESIGN RESEARCH AND DEVELOPMENT

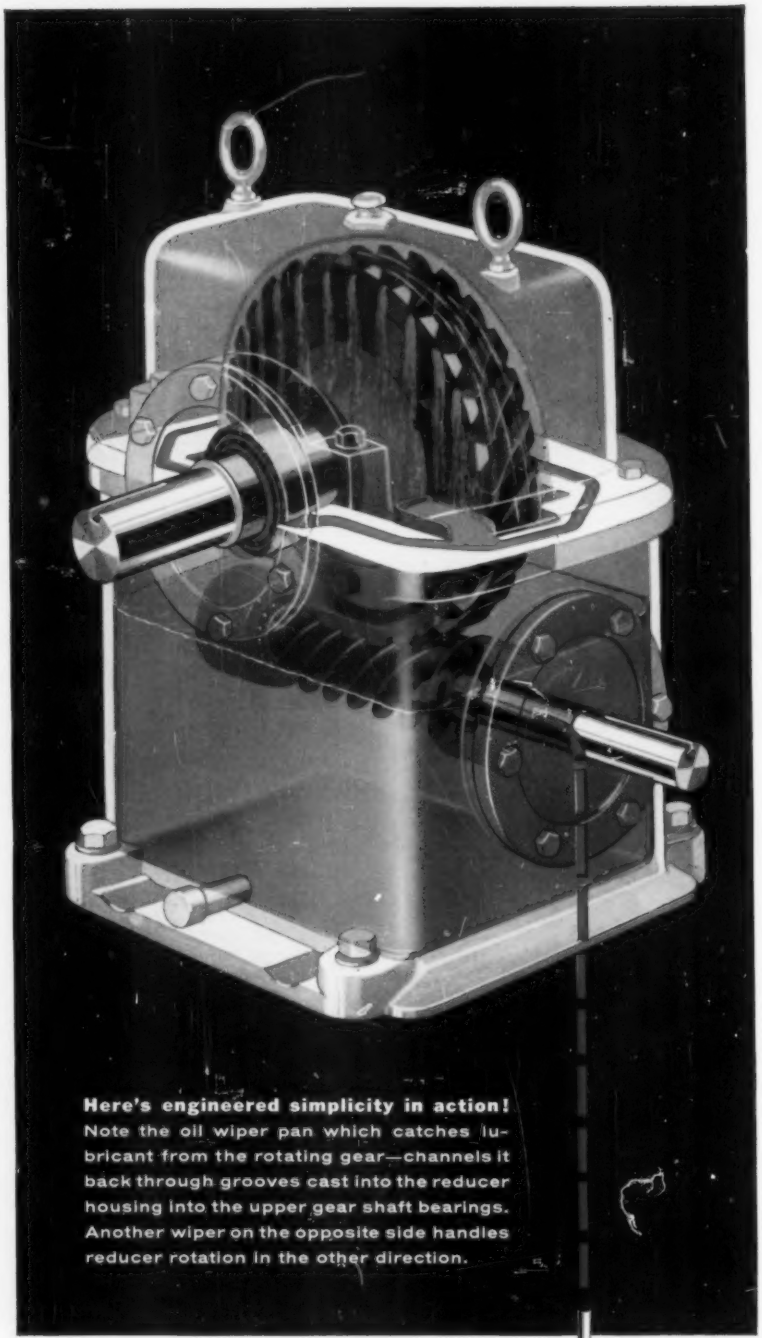
Bellwether with wings—a roundup... see page 5

Automatic, built-in lubrication helps give Clevelands their long service life

Here's one reason why many Cleveland Worm Gear Speed Reducers have provided trouble-free operation day in-day out for over 42 years.

The secret is continuing, adequate lubrication of Cleveland's case-hardened steel worms meshing with low-friction bronze gears. If reservoir is kept filled with good, clean oil, lubrication can never fail.

To get the complete "Cleveland Story", ask for your free copy of our new Bulletin 145. The Cleveland Worm & Gear Company, 3279 East 80th Street, Cleveland 4, Ohio.



Here's engineered simplicity in action! Note the oil wiper pan which catches lubricant from the rotating gear—channels it back through grooves cast into the reducer housing into the upper gear shaft bearings. Another wiper on the opposite side handles reducer rotation in the other direction.

Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers Limited.

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Speed Reducers

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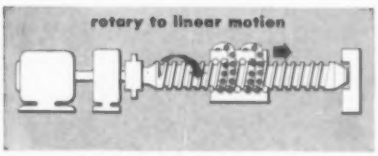

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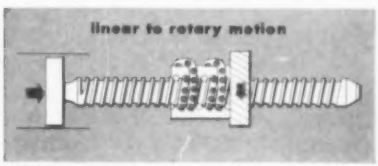

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Product Engineering

THE McGRAW-HILL MAGAZINE OF DESIGN, RESEARCH AND DEVELOPMENT

JULY 7, 1958 Vol. 29, No. 27

SPECIAL REPORT

Bellwether with Wings 52 . . . E. J. Tangerman, Editor
Where the aircraft industry leads in metalworking, others follow. Here are 26 such new areas of development in materials and processes selected for general use—from a plant-by-plant staff survey.

Cantilevers That Roll with the Load * **58** . . . J. D. Howell, Consulting Engineer
Put a curved support under a cantilever spring to protect it from overstress and triple its energy capacity. Article gives the why and how, along with design equations for 7 types.

Design Features in New Products 60 . . . Prestressed spring drives camera aid; giant miller floats in oil; engine is tranquillized by torsion bars; screw positions shot for peening.

Stresses in Adhesive Joints 64 . . . H. A. Perry, US Naval Ordnance Lab.
There's growing interest in putting load-bearing members together with adhesives. Author analyzes 6 basic joints and shows how to calculate their stress concentrations.

Britain's New Variable-speed Motor 68 . . . John Tunstall, McGraw-Hill World News, London
Just turn a handle. It changes stator angle—and the rotor of this spherical induction motor changes speed.

Glass and Ceramic Fibers 70 . . . T. D. Callinan, International Business Machines Corp.
Technology is turning sand and clay into thread-like materials that beat the heat. Design data here is from a forthcoming book, *Modern Materials*.

DESIGN FILE

For Better Electroplating 74 . . . P. C. Noy, Canadian General Electric Co.
Tips on how to handle trouble spots; concludes 2-part article.

Curves Find Compression Strength of Thin-walled Cylinders 77 . . . Irene Kusmiss, Walter Kidde Co.
For cylinders, with and without internal pressure.

DEPARTMENTS

Interesting to Note	5	New Components, Materials	81
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New CUTLER-HAMMER Synchronous Timers Set the Pace in Industrial Control Timer Design and Performance

One minute timer:
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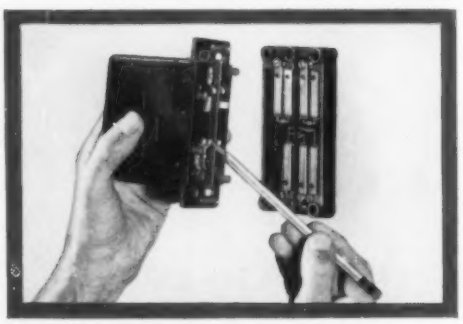

The timing unit is removed from the mounting base during installation. Unique spring contacts mate with terminal strips . . . no inter-wiring necessary. The one, three, and five minute timing units are all the same size and easily interchangeable without disturbing mounting base or wiring.

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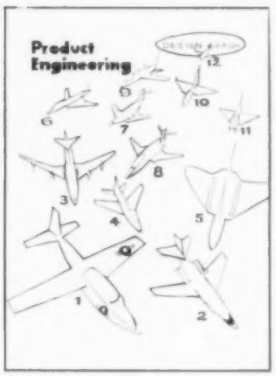

1. Temco—TT-1—Pinto
2. Lockheed—Jetstar
3. Convair—880—Jetliner
4. North American—F100—Super Sabre
5. Douglas—F4D—Skyray
6. McDonnell—RF 101—Voodoo
7. McDonnell—F101A—Voodoo
8. McDonnell—F101B—Voodo
9. Grumman—F9F-9—Tiger
10. Fyan—X13—Vertijet
11. Convair—F106A
12. McDonnell—F3H-2N—Demon

Global Flight

Some months ago (Oct. 28, '57) we pictured 14 current planes, most of them jets. Reaction was very favorable, so this week's cover pictures 12 more, all jets in current production. But Sid Karson, McGraw-Hill photographer, snapped them in an unexpected way—in an intentional double exposure. They're flying over the Atlantic Ocean that is a portion of a 3-D map of the world, molded in thin-gage vinylite sheet. Aero Service Corporation, Philadelphia 20, Penna., makes this map, 42 x 61 in. over-all, as one of a 10-color series ranging from single states (NY, NJ, Penna, Calif) through countries (US, Canada, Venezuela) to continents. This one is faithful to horizontal scale of 1 in. to 434 miles; vertical scale is amplified 50 times for clarity. It has some 3000 geographic names. Prices range downward from this one, which is $47.50. The maps are washable, so can be drawn on with pencil or chalk. Aero also makes 3-D 14x20-in., six-color maps of Civil War battlefields complete with roads, farms and fence lines that existed almost 100 years ago. Price $6.50.

For photographers: The planes, all by Topping, Inc., Akron, Ohio, except for the hand-made Vertijet, were removed from their stands and photographed against black velvet. Then the map was photographed on a second exposure of the same film.

Pynchon's Air-ship

When man originally thought of a mechanical flying machine it was always pictured as a device which would imitate the form or motion of birds. In 1783 the first balloon explored the skies, but controlled flight had to wait until 1905 when the Wright brothers had their day at Kitty Hawk.

Twelve years before the Wright plane took off, Edwin

(Continued on page 7)

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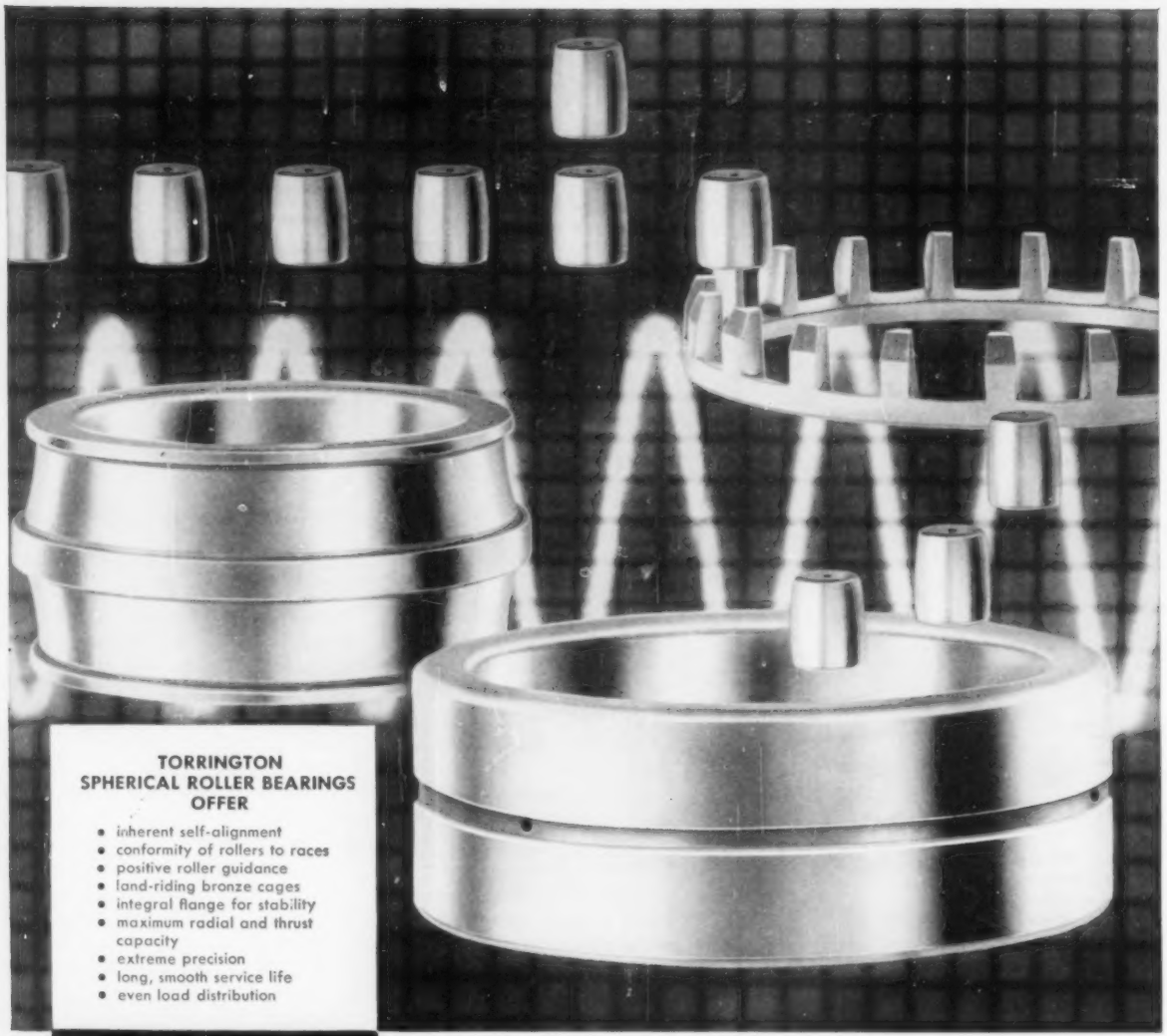

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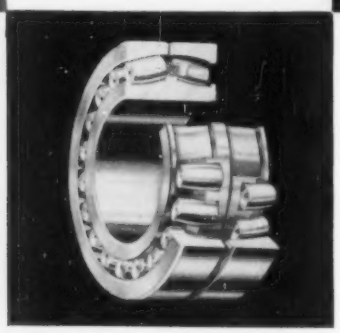

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Torrington's care for these details of accuracy is matched only by our care in matching the *right* bearing to the *right* job. In this, you can rely on your Torrington representative and the facilities of Torrington's Engineering Department. **The Torrington Company, South Bend 21, Ind.—and Torrington, Conn.**

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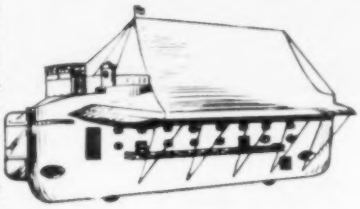


Pynchon, a physician-surgeon and designer of surgical instruments, received a patent for an invention he called an *air-ship*. Looking more like a ship than a plane, Pynchon's design showed great preception. The "ship" was equipped with hydrogen buoyancy chambers, internal ducted propellers and solid exploding charges. Cartridges were fired against a plate at the stern of the craft to act as a forward propellant.

Wings (called *aero-planes*) were set at a slight negative dihedral . . . "*to act as a parachute in descent.*" The craft was steered by vertical and horizontal rudders. Many of Pynchon's ideas were completely impractical—such as a promenade deck for dancing, and side-projecting balconies. Yet his specifications for aluminum as the structural material and his aero-dynamic concepts were far advanced, coming from a doctor 65 years ago.

The aircraft industry has long been considered a bellwether of economy and design. The article on page 52 suggests methods, materials and processes common to aircraft designers that may have applications in other industries as well.

Camera Land

The word Polaroid joined our vocabulary in 1932 when a 23-year-old Harvard student announced his invention before a college colloquium—a glare-proof lens. By successfully aligning iodine-plastic molecules uniformly in a sheet of polyvinyl alcohol plastic, Edwin H. Land produced a lens that restricted the vibration of light passing through the lens to a single plane.

Land, together with George Wheelwright, his former physics instructor, established an R & D laboratory in a Boston cellar and within three years were manufacturing polaroid filters for Eastman Kodak Co. Soon came lenses for sun glasses, then 3-D camera lenses, and finally in 1937, the Polaroid Corp. was established to handle the influx of business. At a meeting of the Optical Society of America 10 years later, Land demonstrated a new invention—a one-step photographic process the Society called ". . . a new kind of photography as revolutionary as the transistion from wet plates to daylight-loading film." The Polaroid Land camera is familiar to all, yet it's still only the beginning for Land. Last month, he was granted his 109th patent, a modification on his one-step camera idea.

In all, Land holds 225 patents. The camera described on page 60 utilizes the Land principle of polarization to simplify movie-making. It makes fadeouts easy for the amateur.

Too Coarse for the Princess

Surely every student at one time has either seen or himself tried bending glass tubing, then pulling it over a flame until a thin fiber resulted. In the Middle Ages, artisans also produced these threadlike strands of glass. They preferred colored glass from which they "spun" decorated goblets and stemware. In Venice during the 15th century, craftsmen assembled colored rods and fibers in the shape of leaves and flowers, then coated them with a clear glass film. These antique works of art are called *millefiori*.

It wasn't until 1893 that glass fibers were used as more than a work of art. At the Columbian Exposition, Edward Libbey set up a glass-fiber-producing unit which actually wove glass and silk together to form a material. This was then made into neckwear, lampshades and a gown for the Infanta Eulalia of Spain. Unfortunately, the fabric was too coarse to be folded, and never was used.

Glass fibers have long since been modified to fit many design needs. Glass, silica and ceramic fibers that provide strength, heat resistance, and electrical and thermal insulation are discussed on page 70.

Galvani vs Volta

Just as there are controversies among scientists today, there have been disagreements ever since ideas were first disseminated. Today we'll argue the cause and effect of atomic energy; 200 years ago it was the cause and effect of electrical energy. When Galvani published his report in 1791, stating that a frog's leg moved when subjected to an electric discharge the scientists of the day were fascinated.

In Italy there lived another scientist, Alexander Volta, who couldn't accept Galvani's thesis that electricity originated in animal tissue. He suggested that what Galvani called "*animal electricity*" actually was "*metallic electricity.*" Volta believed that two dissimilar metals would produce a muscle spasm when applied to any living muscle tissue. After many years' debate, Volta attempted to further prove his point by rubbing rods of glass and resin, to obtain positive or negative charges as a reference, then determine which of several metals would produce the strongest positive or negative charge. For example, Volta found that a copper and a zinc disk in contact would produce a negative charge for the copper and a positive charge for the zinc. However, copper in contact with silver, gold or graphite showed the copper to be positively charged.

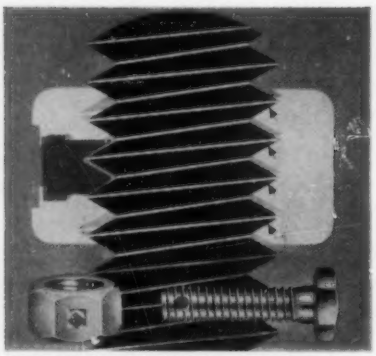
The electrochemical series of metals listed by Volta in 1797 has not been altered—merely added to. The debate between Galvani and Volta was the beginning of a new form of metal technology, electroplating, the subject of the article on page 74.—Benedict A. Leerburger Jr.

DU PONT

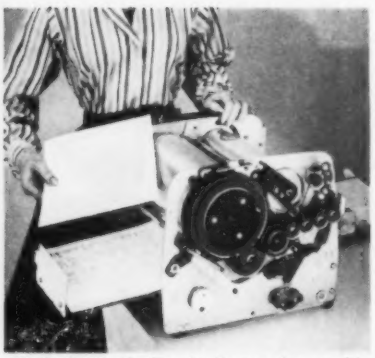
BETTER THINGS FOR BETTER LIVING
. THROUGH CHEMISTRY

PRODUCT ZYTEL®

Here's how Du Pont ZYTEL® nylon resins

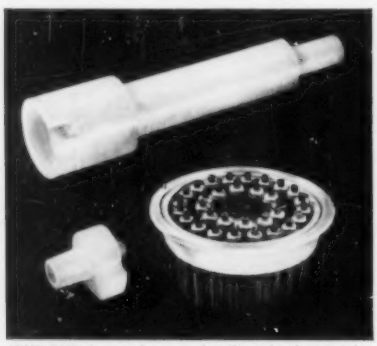


SELF-LOCKING FASTENERS use tough, resilient pellets of ZYTEL to exert powerful lateral thrust. Strong metal-to-metal lock between opposite mating threads results (see arrows). (By Nylok Corporation, Paramus, New Jersey.)

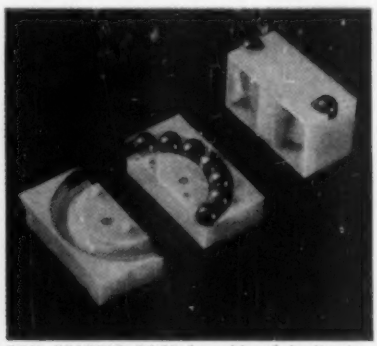


GEAR TRAIN of office duplicator, shown with side cases removed, is made of Du Pont ZYTEL nylon resin. Parts operate quietly . . . are strong and durable. (Molded by Hauser Products, Inc., for Heyer Corp.—both of Chicago, Ill.)

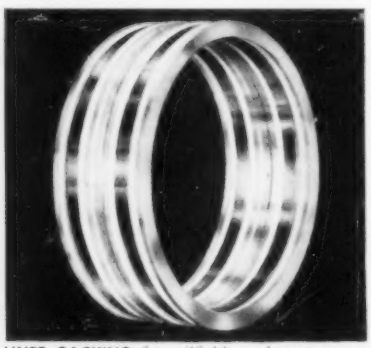
CHECK VALVE won award for best use of materials in design. Parts were reduced from 10 to 6 and their cost cut by 68%. (Molded by Hamilton Plastic Molding Company for OPW Corp.—both of Cincinnati, Ohio.)



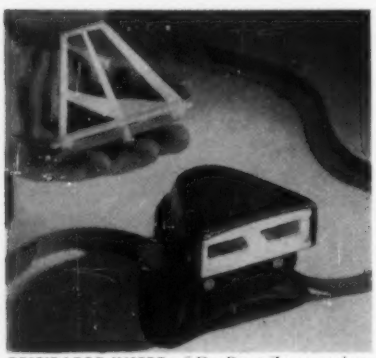
CYCLONE is used to make fine-sized particle separations. The abrasion resistance and chemical resistance of ZYTEL are vital in this application. (Molded by Dickmont Plastics Corp. for Dorr-Oliver Inc.—both of Stamford, Conn.)



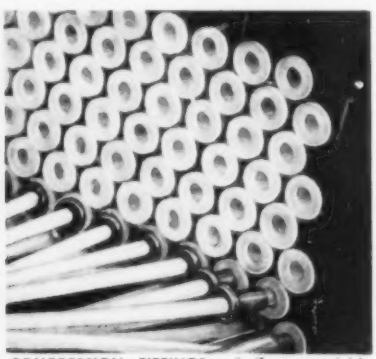
BALL BEARING RACE for table of duplicating miller provides cost savings, smoother table action, high resistance to abrasion. (Molded by Dickmont Plastics Corp., Stamford, Conn., for Regent Machine Co., Bridgeport, Conn.)



LINER PACKING for oilfield mud pump uses big, resilient, chevron-type rings of Du Pont ZYTEL nylon resin to achieve a rugged, close-fitting assembly. (By Blackwell Plastic Molding Co. for Mission Mfg. Co.—both of Houston, Texas.)



RESPIRATOR INSERT of Du Pont ZYTEL nylon resin is easily molded to exacting standards of strength, providing toughness with adequate stiffness. (Made by Wilson Products Division of Electric Storage Battery Co., Reading, Pa.)



COMPRESSION FITTINGS of ZYTEL quickly connect tubing of the same material to the ink supply control board of a newspaper printing machine. (Presslok* fittings by Nylon Molding Corp., Garwood, N. J.; used by Wood Newspaper Machinery Corp., Plainfield, N. J.)

CAP for vaporizer is molded of Du Pont ZYTEL nylon resin in bright pastels. The intricate part has high strength . . . excellent heat resistance. (Vaporizer by Kaz, Inc., New York, N. Y.; cap by Pyro Plastics Corp., Union, N. J.)

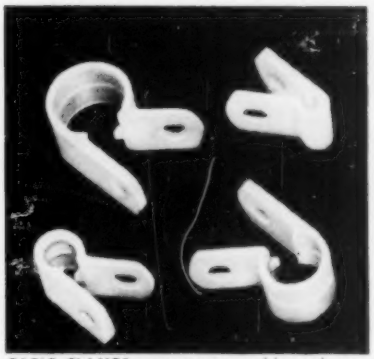
CIRCLE 105 READER SERVICE CARD

ENGINEERING NEWS

NYLON RESINS

improved 14 recent product designs...

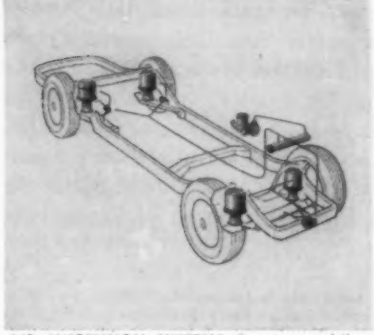
GEAR ASSEMBLY for automatic slide projector insures smooth, silent operation. Low friction of ZYTEL reduces lubrication needs. (Made by Wollensak Optical Co., Chicago, Ill.; parts molded by Thorgren Tool and Die Co., Valparaiso, Ind.)



CABLE CLAMPS secure wire, cable and conduit to structural framework of aircraft. Molded of lightweight, resilient ZYTEL, they form a perfect circle with tongue and groove giving a positive, vibration-proof grip. (Molded by Nylon Molding Corp., Garwood, New Jersey.)

BOAT HARDWARE molded of Du Pont ZYTEL is not affected by sea water, gasoline and oils. Colors complement the finish of the boat . . . high strength of ZYTEL assures safety. (Made by Danielson Manufacturing Company, Danielson, Connecticut.)

PIPE CLAMPS grip fuel lines in jet aircraft . . . withstand strong vibration. Light weight of ZYTEL nylon resin (sp. gr. 1.14) . . . plus exceptional toughness and tensile strength . . . makes it especially useful in airplanes. (By Nylon Molding Corp., Garwood, New Jersey.)



AIR SUSPENSION SYSTEMS for automobiles depend on extruded tubing of ZYTEL nylon resin. Tubing needs no pre-bending, is tough, resistant to abrasion. It can be used with standard fittings and operates over a wide temperature range (-40 to 250°F.).

Outstanding design properties of ZYTEL® nylon resins feature high strength...ease of fabrication

The dramatic improvements in design which started when strong, high-melting thermoplastics such as ZYTEL became available continues to this day, as these recent products show.

Important production advantages are one reason. ZYTEL nylon resins have a high, relatively sharp melting point. Because of this sharp melting point, ZYTEL sets up fast and gives shorter molding cycles. Multicavity dies in an injection-molding process speed up production still more. Extremely complicated and precise shapes are possible. Surfaces can be formed so smoothly and accurately that the need for machine finishing is usually eliminated.

Structurally, parts of ZYTEL have a great deal to offer. ZYTEL nylon resins have the highest strength-to-weight ratio of any plastic. Parts are extremely resistant to abrasion and impact. Owing to its resilience and low surface friction, ZYTEL is commonly used to make gears and bearings. A series of formulations are available to meet a variety of end-use requirements.

SEND FOR INFORMATION

For information showing you how to design with ZYTEL nylon resins, just mail the coupon.

E. I. du Pont de Nemours & Co. (Inc.)
Polychemicals Department, Room 367, Du Pont Building
Wilmington 98, Delaware.

Please send me more information on Du Pont ZYTEL nylon resins. I am interested in evaluating this material for:

Name _____ *Position* _____

Company _____

Street _____

City _____ *State* _____

Type of Business _____

In Canada: Du Pont Company of Canada (1956) Limited, P. O. Box 660, Montreal, Quebec

STEEL SHAPED TO CUT COSTS AND IMPROVE PRODUCTS

Caterpillar track shoe made from USS Special Section Rolled Steel Bars—a fast, low-cost method for making irregular parts.

Caterpillar makes this complex track shoe . . . from steel already rolled to shape!

The famous Caterpillar Crawler Tractors need a lot of shoes to make up their track—so the cost had to be kept low. To produce the highly irregular track shoe sections by machining, forging, casting or welding was either unsatisfactory, too costly or too slow.

They took the problem to U. S. Steel and a special section hot-rolled steel bar was suggested for the desired shape. The track shoes could then be sheared to the desired length. Three simple punching, shearing and drilling operations completed the job . . . and the shoes were ready for heat-treating and painting.

This method permitted more efficient production of track shoes, reduced the amount of steel needed, eliminated slow, costly machining, and cut scrap losses to rock bottom. The final shoe is strong, tough and long lasting.

Long life in rugged service has proved the quality of these shoes used in the endless track of Caterpillar Crawler Tractors.

Since 1928, Caterpillar track shoes have been produced by the thousands from USS Special Sections. No other production method has been devised that can compare with this for quality parts and low costs.

Why not get the facts on USS Special Sections? This is one way you can make substantial cost reductions and gain increased efficiency, too! United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

USS is a registered trademark

USS

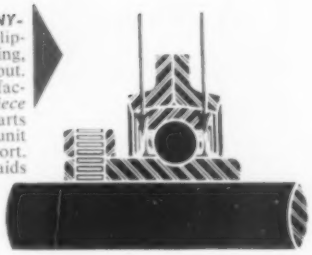
United States Steel Corporation – Pittsburgh
Columbia-Geneva Steel – San Francisco
Tennessee Coal & Iron – Fairfield, Alabama
United States Steel Export Company

United States Steel

Precision ... self-alignment

EVEN IN THIS LOW-COST BEARING

BEST SEAL AVAILABLE ANYWHERE! Synthetic rubber lip-type seal, integral with bearing, keeps lubricant in, dirt out. Bearing is greased at the factory and shipped in *one piece* . . . no juggling of sundry parts in assembly—simply slip unit on shaft and bolt to support. Its compactness further aids design flexibility.

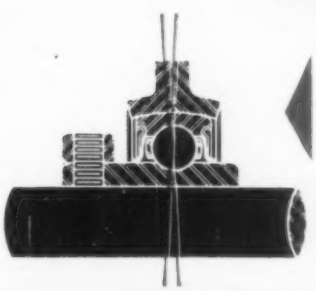


LINK-BELT JPS-200 ball bearings maintain capacity despite shaft and support deflection

IN rugged field service, supporting structures on farm machinery and similar equipment undergo inevitable weaving. Shafts, too, are subject to dynamic deflections. Answer: *self-alignment* — the ability of Link-Belt bearings to adjust under these conditions. And it's yours *at low cost* in this precision Link-Belt ball bearing.

Equally important, Series JPS-200 bearings achieve their economy with *no loss of efficiency*. They combine sturdy pressed-steel housings with standard, full-capacity Link-Belt ball bearings.

Folder 2517 has complete data on the Link-Belt JPS bearing series, and Book 2550 covers the entire Link-Belt bearing line. Get both from any of 40 Link-Belt offices or our authorized stock-carrying distributors.



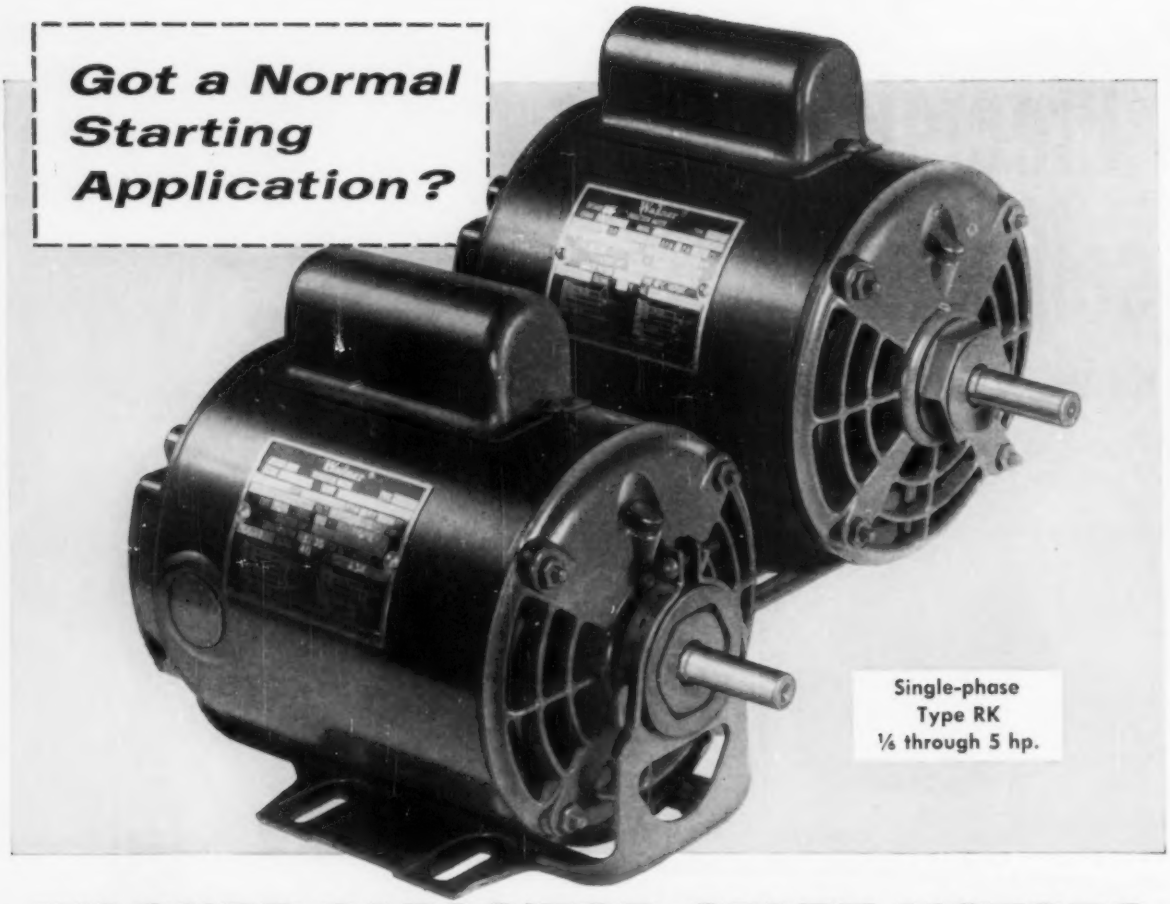
FREE ROLLING AND FULL LOAD CAPACITY are maintained even under shaft or support misalignment with Link-Belt self-aligning feature. Extra-long inner ring of bearing assures proper load distribution. Heavy spring-locking collar firmly secures bearing on shaft.

LINK-BELT

self-aligning ball and roller bearings

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville (Sydney), N.S.W.; South Africa, Springs. Representatives Throughout the World. 14.23F

Got a Normal Starting Application?



Single-phase
Type RK
⅛ through 5 hp.

WAGNER CAPACITOR-START MOTORS

provide dependable starts... long troublefree life

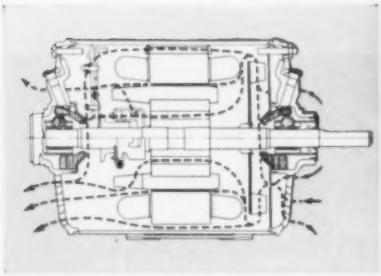
Here's the single-phase general purpose motor that gives more horsepower with less bulk—is rugged enough to permit direct mounting, compact enough to fit in tight spots. Available with sleeve or ball bearings—with rigid bases or with resilient mountings for exceptionally quiet operation.

ALL-ANGLE OPERATION—The sleeve bearing design in fractional hp ratings, has a positive lubrication system that permits operation in any position. All angle mounting can mean important savings in initial costs to manufacturers—can help the design engineer in a tight spot. You can get these motors from leading motor distributors in your community and from Wagner Sales Offices in 32 principal cities. Your Wagner Sales Engineer will be glad to help you select the right motor for your application. Wagner Bulletin MU-217 gives full details.

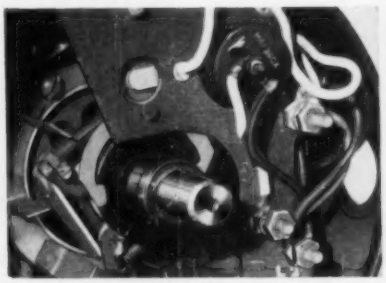
Wagner Electric Corporation 6406 Plymouth Ave., St. Louis 14, Missouri.

BRANCHES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES

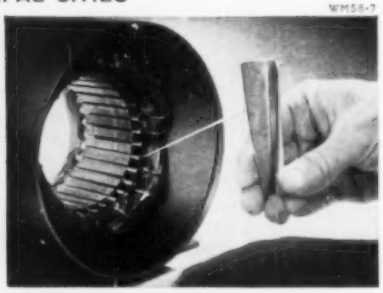
WM58-7



EFFICIENT COOLING SYSTEM—The improved ventilating system used in these motors directs a large volume of air through the motor to effectively reduce temperatures and add to motor life. Cross section above indicates direction of air flow.



QUICK BREAK SWITCH—The starting winding and capacitor are disconnected from the line by this Wagner Switch—test-proved to make more than a million makes and breaks . . . the equivalent of two starts per hour for 50 years.

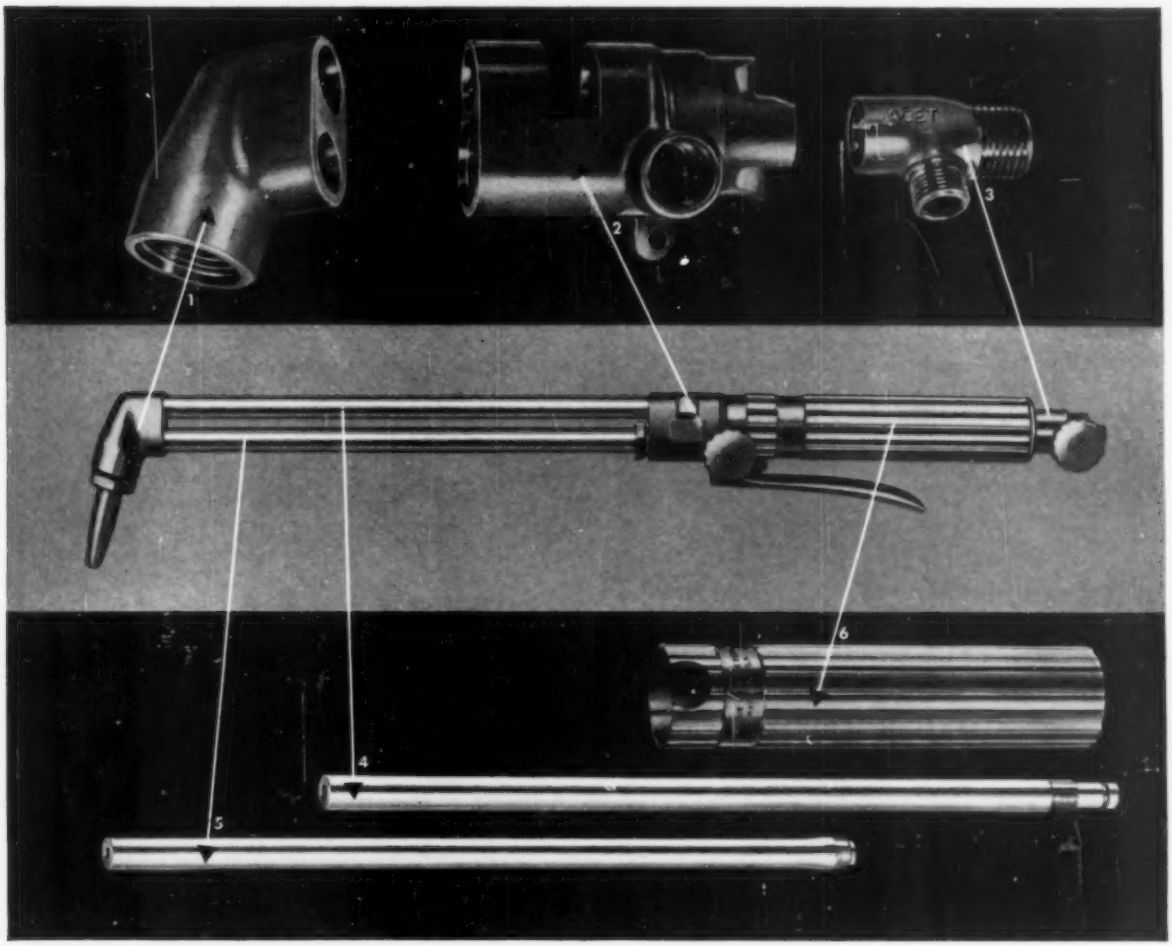


MYLAR* INSULATION — Mylar-paper laminated slot insulation gives top protection against moisture, adds thermal stability, to give more application versatility and longer life when unexpected overloads occur.

*DuPont Trademark

SHORT CUTS to finished products.

Anaconda pre-formed mill products cut time and cost in finishing and machining—reduce scrap losses.



Linde Company's "Purox" Cutting Blowpipe, Type "E," is produced more easily and economically with these Anaconda products. **1, 2, 3.** Die-pressed forgings, with these advantages: twice-wrought metal has denseness to prevent gas leaks; toughness and strength to stand up to abuse; has uniformity, dimensional accuracy to cut machining cost—finishing reduced to bright dip. **4, 5.** Thick-wall tubes of Ambrac-850 alloy to dissipate heat rapidly, prevent overheating and "flashback"; alloy has high strength for rough service, yet has sufficient machinability. **6.** Special-shape brass tube with fluting pre-formed is furnished in long lengths ready for fast, economical screw machine operation.

Cost-cutting possibilities are almost unlimited when imagination is applied to designing with pre-formed Anaconda mill products. Simplify costly built-up assemblies with die-pressed forgings. Cut machining and scrap with tubes and solid special shapes adapted to your needs. For imaginative and practical technical help, write: The American Brass Co., Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. 5849

DIE-PRESSED FORGINGS • SPECIAL-SHAPE TUBES
EXTRUSIONS • FABRICATED METAL GOODS

ANACONDA®

products made by
THE AMERICAN BRASS COMPANY

CIRCLE 109 READER SERVICE CARD

MICRO SWITCH Precision Switches

NEW

Actual Size

We've Miniaturized the Subminiature!

WEIGHT: *1 gram . . . 28 switches to the ounce . . . over 430 to the pound.* SIZE: *.500" long, .200" wide, .350" high.*
CUBIC CONTENT: *.035 cubic inches.* ELECTRICAL RATING: *5 amps-250 vac, 30 vdc. SPDT.*

After a long period of laboratory development, MICRO SWITCH announces this new, highly miniaturized precision snap-action switch and a complementary line of actuators.

We call it the "Sub-subminiature!"

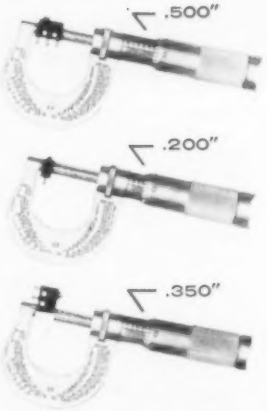
This new "SX" basic switch represents an entirely new set of answers to the space-weight problems in dependable precision switching. It combines new small size with more than ample capacity for wide usefulness, meeting the pressing demand for miniaturization combined with reliability.

In its exacting development, many problems of design, testing and quality control presented themselves. However, 23 years of experience proved of immense value. As a result, a new standard has thus been set by which all precision switches must be measured.

This broad experience can prove of equal value to you. Send for more information about this new switch. Request Data Sheet No. 148.

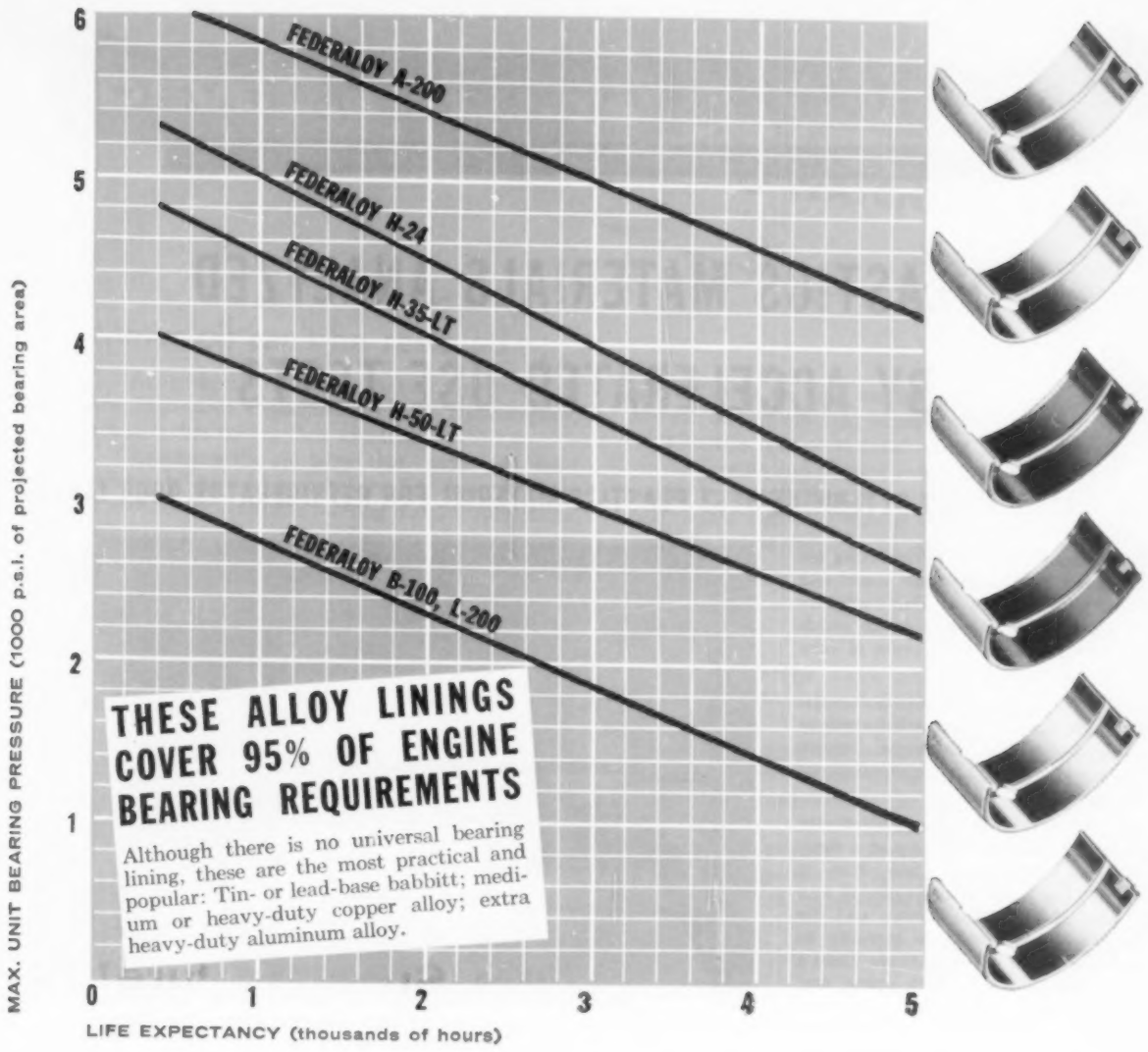
—•—

MICRO SWITCH...FREEPORT, ILL.
A division of Honeywell
In Canada: Honeywell Controls, Ltd., Toronto 17, Ontario



The two-word name MICRO SWITCH *is* NOT *a generic term. It is the name of a division of Honeywell.*

Honeywell
MICRO SWITCH PRECISION SWITCHES


FEDERALOY A-200
FEDERALOY H-24
FEDERALOY H-35-LT
FEDERALOY H-50-LT
FEDERALOY B-100, L-200
THESE ALLOY LININGS COVER 95% OF ENGINE BEARING REQUIREMENTS
Although there is no universal bearing lining, these are the most practical and popular: Tin- or lead-base babbitt; medium or heavy-duty copper alloy; extra heavy-duty aluminum alloy.
MAX. UNIT BEARING PRESSURE (1000 p.s.i. of projected bearing area)
LIFE EXPECTANCY (thousands of hours)
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Our specialized, experienced manufacturing facilities will meet your sleeve bearing requirements and *save you money!* Write for free copy of "Sleeve Type Half Bearing" design guide. Address:

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RESEARCH • DESIGN • METALLURGY • PRECISION MANUFACTURING

JULY
1958

DOW

Plastiatrics

DOW'S CLINICAL APPROACH TO HEALTHY PLASTICS APPLICATION

PLASTICS MATERIALS ANALYZED BY ACCELERATED USE TESTS

DOOR SLAM TESTS DETERMINE BEST PLASTICS MATERIAL FOR REFRIGERATOR DOOR LINERS

Plastic door liners for refrigerators are subjected to considerable wear and abuse while in service. That's why it's so important to select a plastic which will not fail even after years of continuous service.

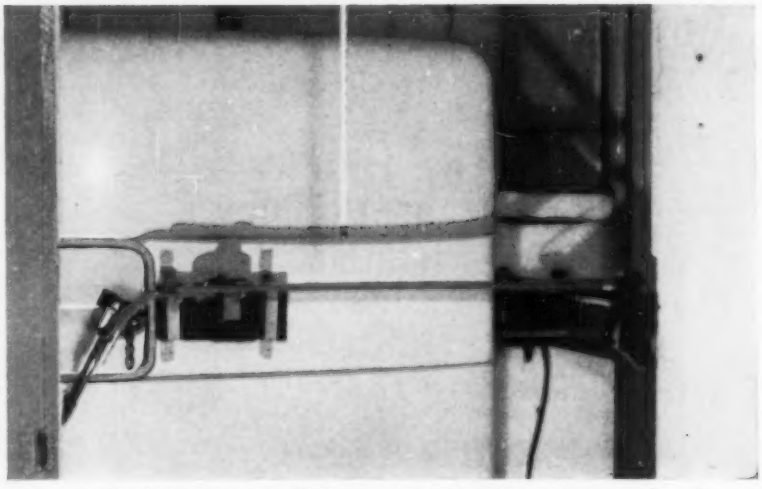
In an attempt to select the best material available for this particular application, Dow Plastics Technical Service Engineers utilize an accelerated-use test device.

Liners molded from various plastics to be tested are installed, one at a time, in a test refrigerator. (See photo at right.) The refrigerator is placed in a controlled temperature room and the shelves are weighted to capacity to simulate actual use conditions. Then a mechanical device which opens and shuts the door automatically is put into operation. It continues to open and close the door until the plastic fails. Failure is defined as the point at which the plastic cracks and the crack is visible to the naked eye.

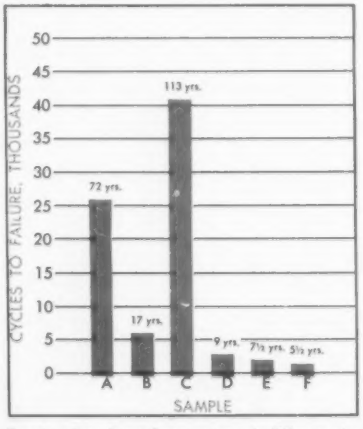
This test will quickly:

1. Select the best material for the application.
2. Provide data on the strength and weakness of a particular door liner design.
3. Define the life expectancy of a given door liner.

This test is but one of many continuing Plastiatrics studies conducted by Dow Plastics Technical Service Engineers. These studies cover every phase of plastics formulation, design, molding and finishing. This particular test has enabled Dow engineers to accumulate a wealth of information concerning correct design procedures. For your copy of the results or information on other areas under investigation, write THE DOW CHEMICAL COMPANY, Midland, Michigan, Plastics Sales Dept. 1523D.



Actual refrigerator in controlled temperature room where tests are conducted.



Results of accelerated-use tests on six different plastic formulations used for refrigerator door liners.

AMERICA'S FIRST FAMILY OF POLYSTYRENES

GENERAL PURPOSE
- STYRON ® 666
- STYRON 666M (Easy Flow)
- STYRON 665 (Extrusion)
- STYRON 689 (Easy Flow)

HIGH IMPACT
- STYRON 475
- STYRON 475M (Easy Flow)
- STYRON 777 (Medium Impact)
- STYRON 440 (Heat Resistant)
- STYRON 440M (Easy Flow)
- STYRON 480 (Extra-High Impact)

HEAT RESISTANT
- STYRON 683
- STYRON 700

YOU CAN DEPEND ON DOW

DEVELOPMENTS TO WATCH...

Motor oil can't be restored . . .

. . . to its original form once it's been used in a modern high-speed engine, says H. L. Hemmingway, research director for Pure Oil Co.

Challenging the old adage that "motor oils don't wear out," he told an American Petroleum Institute Lubrication Committee meeting that not even drastic filtration processes can produce an oil that is "just as good" after use as it was before. The problem is not just one of removing impurities.

"Filtration tests prove conclusively," he said, "that viscosity, color, and additive content are affected materially by usage." Even when the oils are centrifuged and treated with clay, they must be refortified with additives before they can be reused.

Ionization chamber serves as a resistor . . .

. . . in a recently designed Swiss electronic relay.

The high-value resistors normally used, say engineers at Elesta, Bad Rogaz, Switz., do not permit continuous adjustment and so are not entirely satisfactory for charging time-lag capacitors.

So they turned to an ionization chamber and an isotope that emits alpha radiation. This radiation ionizes the air in the chamber, making it electrically conductive. The degree of ionization, and therefore the conductivity, can be controlled by interposing a shielding diaphragm which cuts off as much or as little of the radiation as desired.

Says Elesta, "Even relatively small currents—less than a microamp—can be set very exactly so that time lags of several hours can be achieved with small capacitors." Furthermore, the device is relatively insensitive to voltage variations. A change of 10% in the voltage produces a deviation of only 2 to 3% in the time lag—about ⅛ of that which Elesta has encountered with conventional circuits.

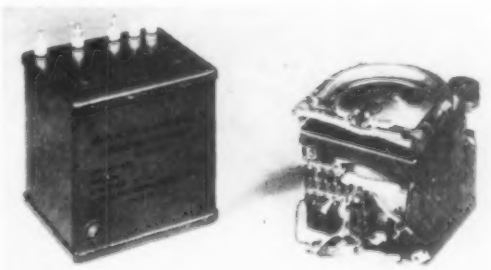
Plastics, stable from –80 to 800 F . . .

. . . are being sought by the USAF; and, says a recent Wright Field report, several metallo-organic compounds look extremely promising. No practical polymers have yet been achieved, but considerable information has been accumulated, and further research is definitely indicated—especially since, as one U. of Illinois report points out, the materials which exhibit thermal stability may also be expected to have excellent chemical resistance. One group of compounds that seems to rate special attention is the phthalocyanines, already used for high-temperature additives and fillers.

A battery that carries its own built-in heater . . .

. . . has been designed by American Machine & Foundry Co. 261 Madison Av., N. Y. It's a 28-v, 20-amp silver-zinc cell containing a "heat powder" that is activated as the cell itself is activated, and provides the heat that "permits the battery to go to work instantly," even at temperatures far below zero. First applications are to be in guided missiles and other military equipment; but AMF expects the principle, and other innovations in battery design coming from its laboratory in North Carolina, to have considerably wider application.

(Note: For more information on batteries, standard and special, see "Dry Cells," *PE*—Feb. 17, p 72, and "Midget Batteries," May 12, p. 72.)



Chemically heated battery, designed to operate at temperatures down to —65 F, is expected to have industrial as well as military uses. Activation time is just 6 sec.

DEVELOPMENTS

TO WATCH...

Magnesium-beryllium alloys . . .

. . . being developed by Russian metallurgists for nuclear reactor use, may have much broader significance. If the combination of these two metals is as effective as that of beryllium and copper or aluminum and lithium (*PE*—Mar. 10, p. 16) it could mean a new series of lightweight structural alloys. Look for an announcement of progress to date at the September International Conference on Atomic Energy in Geneva. (For background information on beryllium, see *PE*—Mar. 17, p. 66.)

Transistor producers are aiming at . . .

. . . frequencies of about 1,000 mc, ambient temperatures to 750 F, and power capability of at least 200 w by 1961, says W. W. Watts, RCA vice-president. He says the transistorized wrist-watch radio and TV set are well on the way too—but isn't predicting exactly when they'll arrive.

Two clear plastic films are ready . . .

. . . for design evaluation, though neither is yet in commercial production. Both are oriented films, offering high strength for the direction of orientation, low moisture absorption, and interesting chemical and thermal properties.

One, from Minnesota Mining & Mfg., St. Paul 6, Minn., is the first material of its type to be made from the new family of polypropylene resins. It has excellent clarity, is soft and flexible, and will stand temperatures from −70 to 300 F. At present, it's available in 0.0005 in thickness, in widths to 30 in., at a tentative price of 4½¢ per 1000 ft.

The other film is an oriented polystyrene expected to be low in cost and offer high clarity, resistance to aging, good dimensional stability, low moisture absorption combined with high gas permeability, high dielectric strength (5000 v/mil at 60 cycles), and a low power factor (0.0002 to 0.0004). Suggested applications range from electrical insulating tape to surfacing for refrigerator inner door liners.

Dow Chemical Co., Midland, Mich., which developed this film, calls it Trycite, and says it is "the first commercially feasible" polystyrene film of its type, though not the first oriented polystyrene. Dow is now marketing the material in limited quantities, in 1 to 2-mil thickness, widths from 1 to 54 in., at prices ranging from 2.36 to 6.69¢ per 1000 sq. in. (roughly 58¢ to 85¢/lb). The commercial-scale production plant, according to present plans, will be onstream next January.

Talking machines are becoming quite the rage . . .

. . . these days. Pre-recorded magnetic tapes have, of course, long been familiar; but computer-type units are relatively new. At its annual meeting, for instance, Hoffman Electronics Corp. unveiled a machine that can "speak" a number of words and phrases when an operator presses the keys of a typewriter feed-in unit. Called *Selvox* (for "selective vocabulary"), the instrument is simply a computer arranged to provide selective readout of information which, in this case, is pre-recorded words and phrases.

Advantages, say Hoffman engineers, are that a coded electronic signal is easier to transmit; less affected by interference and static, and by variations in manner of speech.

The device is still in the laboratory stage; but the company believes it "holds promise for application in solving major problems in aircraft, ground, and shipboard communications."

Voting will be cheaper . . . .

. . . say engineers at Southern California Aircraft Corp., Ontario, Calif., if their new electronic ballot tabulator gets into general use. Featuring a computer "no bigger than an office desk," the unit is said to be capable of counting more than 100,000 votes an hour—scanning each ballot and posting the count as fast as ballots can be inserted.

—ARG

How Foreign Car Design has Changed since 1950

- **McGraw-Hill World News spotcheck reveals that British auto sizes, weights, remain constant.**
- **Volkswagen-makers actually increase demand by refusing to vary models.**
- **Italy's Fiat size is reduced, horse power increased.**

LONDON—British auto designs since 1950 have moved toward American styling, lower specific engine weight, and reduced fuel consumption. Size has remained about the same.

Almost every model introduced since 1950—roughly 75% of British cars—has cut weight 10 to 15% through integral construction. Once a car is introduced, its weight is seldom pared significantly during subsequent development. Despite integral construction, specific weight of British cars in the popular economy class is significantly higher than weight of their continental cousins. This stems from British preference for water-cooled engines and continued use of relatively thick gage panels—0.032 in. to 0.036 in.

Some manufacturers say thinner gages—0.026 in.—common on the Continent could harm British sales in spite of weight advantages. Though adequate structurally, thin-gage panels can be dented by thumb pressure, a characteristic that customers might think incompatible with safety. But then too, one body maker complains there is no British steel specification that combines thin gage with necessary formability characteristics.

In engine development, British car designers have chalked up several improvements: They have introduced the overhead valve engine; progressively increased engine speed from 4000 to 6000 rpm; raised compression ratios from 8:5 to 9:1 as high octane fuel came on the market; increased capacity of existing blocks; and sharply reduced fuel consumption. Much of this development was achieved with the basic structure and components of existing engines.

Engines under 1500 cc were improved around 1956 by several manufacturers when low-cost lead-bronze indium-coated shell bearings became available from a new bearing plant. Before that, these bearings had been prohibitive for all but sports cars.

Suspension and transmission systems have not changed since 1950—the Hotchkiss drive continues to be standard equipment. No popular car offers standard 2-pedal drive, but most offer a choice of two semi-automatic systems using existing synchromesh gearboxes for an additional $50.

After the war, auto design swung in favor of steering-column gearshifts but some notably bad systems evolved. Hence, a trend back to floor gear change ensued for all cars except those with bench-type front seats. Torsion bar springing, introduced with the Morris Minor in 1948 and used by British Motor Cars (BMC), has not been adopted elsewhere.

Principal economy cars in Britain are the Morris Minor with its variants, and Ford's 2-door Anglia and the 4-door Prefect. Sales run about the same for both and exceed any other makes.

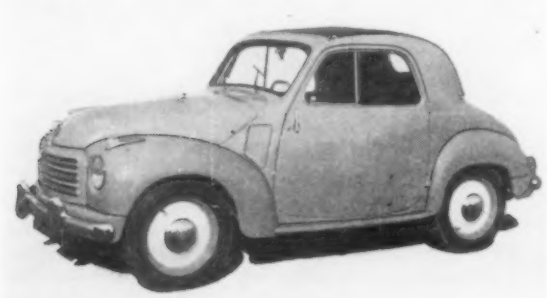
When introduced in 1948, the 1730-lb Morris Minor had an integral body that was 148 in. long, 61 in. wide and 60 in. high. Wheelbase was 86 in. by 50 in. Metal thickness ranged between 0.032 and 0.036 in. None of these dimensions or weights has changed since then and all the principal body pressings are still in use.

The original 2-door model had a 4-cylinder, 918-cc side-valve engine that developed 29.5 hp at 4400 rpm. During 1952-53 a small overhead valve engine—already installed in other BMC products—replaced the side-valve engine. The new 800-cc powerplant developed the same hp as the old but at 4800 rpm.

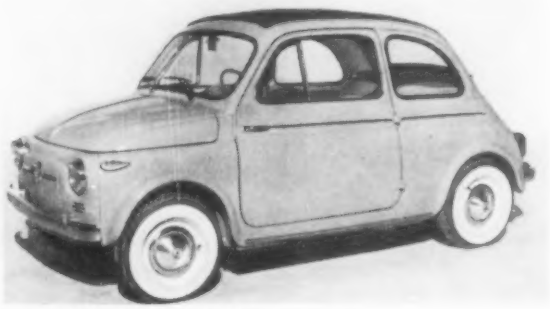
The Morris Minor 1000, introduced in 1956, included another major engine change. From basically the same powerplant, output was raised 16% by increasing bore size and enlarging engine capacity to 948 cc. In addition, compression ratio was upped 7% to 8.3:1. The engine produced 37 hp at 4800 rpm. Top speed rose from 62 to 73 mph and fuel consumption from 40 to 48 miles per gal.

Up to 1953 Ford produced two cars of prewar design, the Anglia and Prefect. Both were redesigned in 1953 and, apart from minor trim and ornamental modifications, designs have remained static.

The prewar Prefect was slightly larger than the Anglia, but now both have the same dimensions and are slightly shorter, wider and lower than their predecessors. The new cars are 150 in. long, 61 in. wide, and 59 in. high, with an 87-by-48-in. wheelbase. The old Anglia was 152 in. long, 56 in. wide, and 64 in. high, with a 90-



This was Italy's Fiat 500 sedan in 1950 . . .



. . . and here it is in 1958.

by-45-in. wheelbase. The Prefect was 155 in. long, 56 in. wide, and 63 in. high, with a 94-by-45-in. wheelbase.

Side-valve engines power both the old and new Fords. Size of the engine bore for both the new models and the prewar Prefect are the same and the engines have a capacity of 1172 cc. The old Anglia's capacity was 933 cc. Redesign has raised compression ratios from 6.3:1 on the Anglia and 6.16:1 on the Prefect to 7:1 on both the current versions. Horsepower has jumped from 23.4 on the Anglia and 30 on the Prefect, to 36 hp on both new models, at 4400 rpm, up from 4000 rpm. Fuel consumption inched down from 30 to 25 miles per gal.

The Ford cars have three forward gears in constant mesh and synchromeshed in top and second. Brake dia, was raised from 7 to 8 in 1954 to solve a squeal problem and standardize brake equipment with the company's commercial vehicles.

Germany's Volkswagen

BONN—Volkswagen has remained practically unchanged since the first model rolled off the assembly line in 1946. And no departure from the static design is now in sight.

From the first, Volkswagen models measured 160 in. long, 61 in. wide and 59 in. high. Front-wheel distance is 51 in., rear-wheel distance 49 in., and wheel base is 94 in. Empty, the Volkswagen weighs 1600 lb and can carry 837 lb.

By foregoing annual model changes, the Volkswagen company says it saves millions of dollars for retooling and —strangely enough—has increased demand. Car buyers, particularly Germans, are confident the vehicle's exterior will look "modern after several years, and its value will drop less than that of competing cars.

Some engineering improvements have been added to the Volkswagen, however. In April 1950 the "export model," which now accounts for the bulk of domestic sales, got hydraulic brakes, and in 1952 it was equipped with synchronized gears. The standard model is still delivered with mechanical cable-line foot brakes and unsynchronized gears. In January 1954, horsepower of all models was upped from 25 to 30.

Other slight improvements are added every few months. These have included reduced valve play, addition of an oil bath and air-filter, better heating system and shock absorbers, and rearrangement of panel board. The middle bar of the rear window was eliminated in March 1953 and window size was enlarged in August 1957. At the same time, windshield pillars were made thinner to improve all-round vision.

Many Volkswagen design improvements go unnoticed. The company places one big ad in the better German newspapers and magazines around Christmas. After making this "gesture" the company sits back a year before placing another ad.

Italy's Fiat

MILAN—Fiat's economy car, the 500 sedan, has grown shorter, lower and wider between 1950-58 (photos, previous page). It now holds four people in place of two. Vehicles from the assembly line now are 9 ft 8 in. long, 4 ft 3 in. wide and 4 ft 2 in. high. Eight years ago they measured 10 ft 11 in. long, 4 ft 2 in. wide and 4 ft 6 in. high. Over the time span, wheelbase was reduced from 6 ft 6 in. to 6 ft.

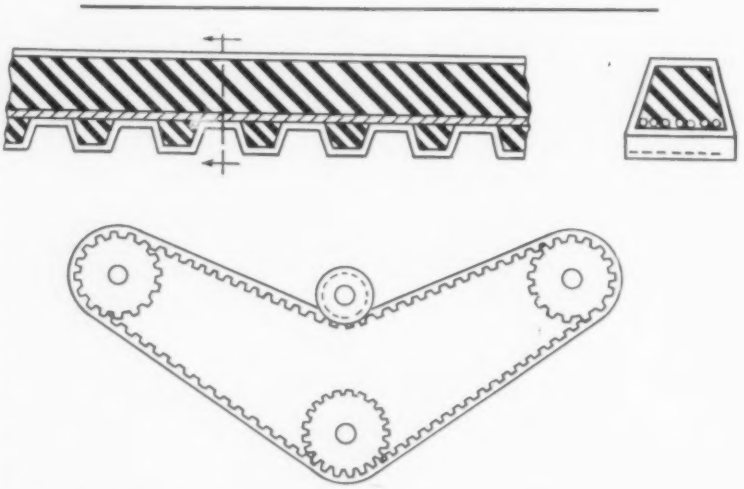
Design evolution has moved the engine from the front to rear and substituted a 2-cycle, aircooled engine for a 4-cylinder watercooled powerplant. Horsepower has remained constant at 16.5 and the single-choke carburetor fuel injection system is still used on the motor that now gets 51 miles per gal. compared with 47 in 1950.

Transmission is still designed for four forward speeds and reverse. On the new 500 model the gearbox is designed for quickly engaging 2nd, 3rd and 4th speeds with final drive in the gearbox. On earlier editions 3rd and 4th speeds were synchronized. Drum dia of brakes has dropped from 7 to 6 in. while lining thickness has remained the same.

In new models, front independent-wheel suspension has transverse flat leaf bottom springs and arms at top. Independent rear suspension has swinging arms and coil springs. In the older cars, independent front-wheel suspension had upper transverse flat leaf springs with arms and stabilizer bar at bottom. Rear suspension was furnished by two longitudinal leaf springs.

Styling alterations have featured substantial increases in window area. Present models carry 12.05 sq ft of window space in contrast to 7.32 sq ft eight years ago.

In Fiat's 1400 there have been minor dimensional and design alterations. The 1958 vehicle is an inch longer—14 ft 2 in. against 14 ft 1 in. over the 1950 model—but width,



A combination . . .

timing and V-belt, just patented by A. E. Carle, Detroit, has the advantages of both, permitting combination of friction and timing drives with the same belt. Basically, the belt consists of a "strain resisting element" or cord along the belt's neutral axis, with a time belt construction on one side and a V-Belt construction on the other. The V may be pointed toward the center of the belt or away from it. In one construction the timing belt element is recessed into the belt, permitting the belt to act as its own guide over unflanged timing wheels.

height and wheelbase have remained the same.

The engine is basically the same design—a 4-cylinder powerplant in front—but it now produces 58 hp against 44 hp eight years ago. A twin-choke automatic carburetor with automatic starter has replaced the single-choke carburetor. Gasoline consumption is slightly better—23.5 miles per gal. against 22.

Transmission shaft in the new 1400 models is designed in two sections, in place of a single section in the 1950 model.

Styling characteristic of European cars is dominated by increased glass area, which now measures 18.5 sq ft compared with 14.42 sq ft in 1950. The newer Fiat cars are making greater use of plastics for trimmings, seats, steering wheels, instrument panels, pipes, etc.

Solid Fuels Get Super-small Powder

CAMBRIDGE, MASS.—Ultrafine aluminum powder as a thrust booster for solid fuels is being tested by major rocket fuel and engine manufacturers. Produced by National Research Corp. through a new, as yet undisclosed process, the new powder particles have less than 0.1 micron dia with figures as low as 0.01 micron on some batches. Particles are globular—not spongy or plate-shaped—with a bulk density of 15 lb/cu ft. In spite of its high surface area-to-weight ratio, the powder is said to be stable in air and easy to handle. Chemical analysis show a 99+% aluminum composition and an "evaluation price" of $55 per lb. Compacting characteristics for powdered metal parts is still being tested.

Over 50 polyester glass moldings . . .

join to form the body of Britain's Peerless Motor's new lightweight and high-speed—1950 lb, 120 mph—Gran Tourisme coupe. Being molded by the James Whitson Co. at the rate of 100 a month, the car is designed to hold 4 persons and has a twp-liter engine and four-speed gear box similar to those in the Triumph TR 3. Using a De Dion-type rear axle, the differential is secured to the chassis with rubber insulation. The chassis frame consists of rectangular steel tubing welded together. Front wheels have Girling disk brakes. Base price in England is $2,794.

It's Not Unanimous on Control Panel Symbols

HARROGATE, ENGLAND—There was an airing of views, though not exactly a meeting of minds, at the get-together of the International Standards Organization Machine Tool Control Panel Symbols Committee. No final decision was made on what symbols to use for various machining functions (*PE*—May 12, p. 88). Member countries will now review the proposals made, to find those most suitable pictorially and economically to produce.

For instance, the French proposals, which ran to many pages, included drawings of rabbits and snails—the snail signifying normal speed. The committee felt such symbols were completely uneconomical to produce. German and Hungarian proposals had been before the committee.

The American attitude surprised the meeting in calling for many additional symbols. The US representative to the meeting, A. W. Meyer of Brown & Sharpe Mfg. Co., claimed many machine functions had been excluded. The US committee will now have additional time to come up with symbols it wants added. It is known right now that many of the proposals will not be acceptable to US designers.

Foreign countries have been more active on this particular committee than has the US. Germany, for example, already has its own symbols for the machine tool industry. One reason for this foreign activity is that the foreign countries sell more equipment outside their own boundaries than does the US. This has been true for some time, but since many US companies recently have acquired branch manufacturing plants in Europe, American interest in control-panel symbols has increased.

There are two American schools of thought on the symbol problem. One favors control panels which have symbols for equipment destined for overseas shipment, and worded panels for US-used equipment; the other desires a combination of words and symbols which will give way to just symbols.

Still another study to be made is to determine what connotations the symbols have in foreign countries.

It was thought that the US was lagging in the development of symbols for machine tool control panels. An ISO spokesman at the meeting disagreed, but pointed out that "in the US, with so many large firms like small empires on their own, standardization is particularly difficult."

Another problem affecting US participation on this committee is keeping one representative permanently attached to the committee when it meets on foreign soil—an alternative to having a representative attend the meeting just because he happens to be going abroad.

AEC Probes Radiation

WASHINGTON—Accelerating development of economic high-level radiation for industrial processing is the motivation for a recently-signed contract between the Atomic Energy Commission and a group of companies embracing the chemical, electronic and metallurgy fields.

The $86,847 contract was signed formally by the AEC and Emerson Radio and Phonograph Corp., General Aniline and Film Corp., and Revere Copper and Brass Inc.

Scope of the study is measured by indicated activities that include: (1) a survey of world technology on current and foreseen uses of high-level sources of gamma radiation; (2) a survey of US industry's uses of large gamma irradiators; and (3) a comparison of the technical, economic and management advantages and problems associated with potential applications of high-level radiation with advantages and problems of other energy sources or chemical agents.

Contract will be administered by AEC's Office of Industrial Development. Emerson has also engaged Arthur D. Little, Inc., as technical study subcontractor.

Government, Prime Contractors Show Subcontracting Opportunities

HUNTINGTON, W. VA.—Government effort to pump defense contracts into labor-depressed areas was given its biggest test to date at the business opportunities exhibit here. A similar, but smaller, exhibit will be held at Hartford, Conn., July 9-11. Later this fall, an exhibit will be held at Portland, Oregon.

Just how successful the government is in drumming up work in hard-hit labor areas is difficult to determine. Some immediate results are produced; others take months to develop. All in all, however, the exhibits are rated as successful.

These shows consist of two elements: government—primarily Department of Defense—and prime contractors lay out a sample of the products for which they subcontract, and local industries display examples of their production capabilities. The idea is that local contractors can make a pitch for subcontracting work and the primes can see what the companies have been producing. Plant tours are arranged for the primes by companies in the immediate area.

Some 90 companies and government agencies participated in the Huntington exhibit. From government, it included the three military services, the General Services Administration, Commerce, etc. Some of the industrial companies with exhibits were Texas Instruments, Inc., of Dallas, Forestone Steel Products of Akron, Lockheed Aircraft Corp. of Marietta, Georgia, the Wright Machinery Co. Div. of Sperry Rand Corp. of Durham, North Carolina, Chance-Vought Aircraft of Dallas, and The Martin Co. of Baltimore.

Each booth was manned by qualified purchasing agents. Most companies labeled products on display with the yearly amounts bought and the last price paid for them. In addition to items shown, most came with stacks of blueprints and specifications.

Until the last evening of the three day show, the general public was barred from the exhibit. It meant that the more than 500 businessmen that came to the exhibit had plenty of time to talk with company representatives, uninterrupted by crowds.

Although the bulk of the business representatives came from the immediate area of Huntington, some came from as far away as Wisconsin and North Carolina. Typical of the nonlocal companies that were scouting for work were: The National Electric Coil Co. of Columbus, Ohio; Paragon Electric Co. of Two Rivers, Wisconsin; Sharon Steel Co. of Sharon, Pa.; The Landis Tool Co., Waynesboro, Pa.; Macomson Machine Co., Shelby, N. C.; and The National Aluminate Corp. of Chicago.

What Exhibitors Said

Texas Instruments' representatives termed the show a success. His company is interested in finding new qualified subcontractors for airborne electronics, and he found several companies that "seem promising."

Many of the items Texas Instruments needs in quantities of less than 500; hence they have trouble getting big companies to bid. Army's Philadelphia Quartermaster Depot found many of the Huntington area firms interested in supplying such items as metal flag poles, insiginas, etc.

In some cases, the exhibit brought two local companies together to turn out a finished product. Metal flag poles, for example, must be demagnetized. The Thomas O'Neill Machine Shop of Huntington could make the poles, but wasn't equipped to demagnetize them. So, it arranged with another local shop, the Star-Delta Electric Motors, Inc. to handle this end of the job. Now, both companies are set to bid on government work.

Some companies said privately that it had been a waste of time. One big aircraft manufacturer said it had lots of inquiries about work but found most of the local firms to be 5 to 10 years behind the state of the art for production of aircraft parts. Others, obviously not willing to be named, admitted that they had been "invited" by government agencies that had big contracts placed with them. However, many departed with additions to their bidder's list.

Promotion of the Huntington exhibit started last fall when some $10,000 was put up by the Chamber of Commerce to finance the housekeeping. Exhibit space was given free to the participating companies.

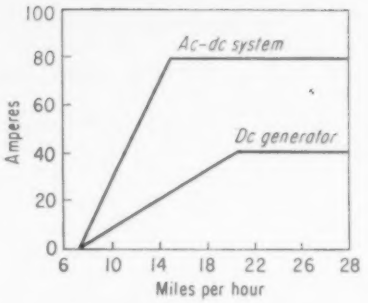
Army explains . . .
how to get bidders' list. Lt. Col. Frank A. Bogart, commanding officer of the Pittsburgh Ordnance district for the Army gives details to S. O. Watts of Huntington and Stanley M. Jessen, Southern Airways Co. of Atlanta, Ga. Products on table and specs on bulletin board are typical of what Army ordnance buys. At other booths, exhibitors showed typical products subcontracted with detailed specifications.

Wide range of products . . .
were displayed in 90 Huntington booths General public was barred until final evening. But, some 500 businessmen scouting for new work came to the exhibit. Without the crowds, small groups could talk in earnest. Serious discussions started at the exhibits were carried on in hotels and restaurants. Often company met company even though some area. Although selling was not a prime factor, some sales were made.

Trucks Switch to Ac-dc System

DETROIT—The 1958 Super Service trucks of the Ford line are equipped with an alternator (ac-dc) electrical system in place of the traditional dc generator. This is the first time an alternator has been offered as standard equipment on a line of vehicles, according to Felix Giordano, Detroit Editor of PRODUCT ENGINEERING. The Ford system is manufactured by Leece-Neville.

For cars or trucks that make heavy demands on their electrical systems or where reliability is essential, ac-dc possesses substantial advantages. The system has proved out on police cars, ambulances, and taxis that use 2-way radios—generally on vehicles that idle for long periods, or make frequent starts and stops, and on heavy-duty off-the-road equipment. Trouble-free performance for as much as 100,000 mi is listed by designers as a major attribute of the system, as well as fast recovery and steady output under varied conditions.



Comparative output . . .

of the two electrical systems. Present major manufacturers of the Ac-dc system for automotive use are Leece-Neville Co., and the Delco Div. of General Motors Corp.

THE SPEED PROBLEM

The output of the ac-dc system rises much more rapidly than that of a dc generator as the vehicle gains speed (see curves). At 14 mph a typical ac-dc unit produces 80 amp; a dc generator, 20 amp. Output of a dc generator can be stepped up by altering the size of its generator pulley to increase angular velocity of the generator. But the advantage of this adjustment is cancelled by multiplied maintenance and wear, particularly on commutator brushes.

Major components in ac-dc systems are in alternator, rectifier and voltage regulator. The alternator, belt-driven from the vehicle's engine, generates 3-phase ac which is rectified to dc. The rectifier is a dry-plate bridge construction—plates being constructed of copper sulfide or selenium, depending upon output requirements.

The regulator unit is composed of a load relay, current limiter, and voltage regulator. The load relay remains open when the engine is off, to prevent battery discharge through the rectifier; and is controlled by the ignition switch so contacts will close before the engine starts. Designs may vary for the voltage regulating function, which consists of opening contacts when voltage exceeds a set level and routing the field current through a series resistor. In some designs, arcing and pitting that normally occur with open contacts are reduced by using lower resistance values and switching the armature to a lower set of contacts.

THE COST PROBLEM

For passenger cars, the alternator electric system is probably still too expensive for standard equipment except where electrical demand is high and variable. This is true even though electrical breakdown is a principal cause of road trouble.

The American Automobile Assoc. estimates that electrical failure accounted for over 24% of auto road failures in 1957, 22½% in 1956 and 24% in 1955. The 12-v electrical system now standard in American cars, and the 24-v system in Army vehicles are an improvement but do not correct the basic cause of failure.

Multiplication of electrical accessories on cars may speed adoption of the alternator system. New autos have three systems—electric, pneumatic, and hydraulic. Some designers say there should be fewer, and of the three, only the electrical system is absolutely essential.

Ford is including the Leece-Neville system as standard equipment on several truck lines: C 900; C 1000; C 1100; F 900; F 1000; F 1100; T 900; T 1000; and T 1100. The equipment is reported to be optional on all other Ford trucks as well.

Bits and Pieces

North American Aviation has announced development of a lightweight, compact radar system, NASARR, that operates at both low and high levels and for air search, automatic tracking, ground-mapping and terrain avoidance. . . . An electronic "jet engine" simulator has been added to present Link Aviation simulating equipment used for training pilots of jet aircraft. A one-half scale cutaway model of a jet engine is used along with cockpit stations for pilot, co-pilot and systems engineer, and a console for the instructor. All sections of the "engine" are backlighted in such a way as to duplicate the operation of the engine from start to shutdown.

The University of Michigan Engineering Research Institute, has been renamed University of Michigan Research Institute and henceforth will administer contract research in all disciplines. The Willow Run Labs will continue as a separate research unit with director and executive committee. . . . An aluminum tugboat with ½-in. bottom and side plate and ⅜-in. deck plate is undergoing trials following launching in New Orleans.

New Hardenable Titanium

Crucible Steel has developed a series of three hardenable titanium alloys with ultimate tensile strength well over 200,000 psi, with no loss in corrosion resistance. For the highest strength alloy, B 120AVC, in the solution heat treated state, yield strength is about 120,000 psi with 10 to 15% elongation, and the material has sufficient ductility to withstand considerable forming. After hardening or aging 50 to 100 hours at 850 to 900 F, yield strength is 170,000 to 240,000 psi depending on the heat treatment selected. Elongation ranges from 6% for the lower strength heat treatments to 2% for the highest strength. Yield strengths at 600 to 800 F can be as high as 140,000 psi. Complete information on physical properties will be included in the next Design edition.

READER TO EDITOR

New Model Every Year?

To the Editor:

Your Points of View, "Must a consumer have a new model every year?" (June 2, p. 30) was the silliest thing in a long while. Only one man, Mr. Teague, gave an answer that did not involve redundancy. The rest started their statements with a sentence which was demonstrably incorrect if not an outright falsehood. Had any one of these four men said anything else, they would have been looking for another field of endeavor the day after the articles came out.

In reference to the "Flying Car" (Apr. 21, p. 23) what do you do when going around curves? How about pebbles on the road, frost heaving, pedestrians, pilot's licenses, etc.? The Big Industries seem to be too much interested in selling "More Go" and less "Do and enjoy." Where are you going to go? Nowhere. What are you going to do when you get there? Come back.

—Lloyd A. Buchalter
Ridgefield, Conn.

• What else could you do except look for a parking place.–Ed.

To the Editor:

Mr. Teague's comments are completely true and accurate. Mr. Whitting's statement that new models give advertising and promotion men something to write and talk about is at least candid—but in what way could that be important to those of us who are not admen, promoters or salesmen, just the suckers who hold the bag?

Speaking of autos, where are the new developments? 1958 autos are the same as 1910 autos in all important respects—some novelties are worthwhile, as the electric starter. Radiator millinery, posterior sheet-metal plumage, fireworks tails and gaudy painting can hardly be classified as serious development.

I believe that with the present state of our economy, unbalanced and inflation-ridden as it is, the sensible thing would be to rationalize and standardize transportation equipment. About three basic types should suffice: A light two-seater commuter with a four-cylinder engine, a five or six seater medium-heavy family car with four or six cylinders, and a heavy luxury car with eight cylinders and preferably a diesel engine. Such cars should be built for 10 to 15 years minimum service life, and should be rugged enough to stand the average extent of punishment without necessitating more than nominal expense in upkeep.

Improving technical intelligence of the public makes more buyers aware of the inconvenience, impracticability, and economic unreasonableness of unhandy, overdimensioned (and frequently underdesigned) mammoth carriages. Maturing of the public taste is evident in lessening response to showy, overblown sheetiron millinery overlaid with cheap glitter. Possession of a bulky automobile is no longer a mark of social prominence. Slums of industrial cities are frequently characterized by an abundance of showy and oversize vehicles sitting in front of shabby dwellings.

Auto makers have overplayed their hand. The public, having in the past fallen for the tricks of the sales magicians almost to the point of no return, are getting tired of the Gospel according to Detroit and ready for a swing to common sense.

—Max Wulfinghoff
Erlanger, Kentucky

A Means for Establishing Communications

To the Editor:

The creative thinker has lost confidence in American Industry which has demonstrated time and again its total lack of ethics in dealing with independent creative thinkers. Now these inventors distrust all dealings resulting in a stalemate and a great loss to progress. I would like to suggest a means for establishing communication between the generators of ideas and industry itself.

The first step would be for industry to have a representative speak with the independent inventor at his or her home. Let the two evaluate the idea using an Evaluation Chart. With a list of company standards in front of the inventor he immediately educates himself as to the many complications there are between his initial concept and the fruitful production and distribution of a product by the company.

A review of this type can quickly and economically bring the creator's ideas before industry. This is valid regardless of the stage of the invention. The first contact with the independent inventors has long been a weak link in the idea-to-product chain.

The absence of freedom of creativeness frustrates the individual thinker and stagnates our economy. To rectify this cancerous ailment I would suggest the following three steps:

1. It must be prohibitive for a firm or its representatives to ask an inventor to negotiate under the condition that the inventor rely *entirely* on the US patent laws for his protection.

2. Industry and Government must repair the damages done to our patent laws by the action of Justices Douglas and Black—"gadgetry is unpatentable." Our greatest inventors started out by creating gadgets. The fostering of gadgetry will be a terrific stimuli to individual creativeness.

3. Leaders of industry must formulate a plan whereby the independent inventor (the lone-wolf searcher, the thinking housewife, the person who experiences a problem to which he generates a solution) will be encouraged rather than discouraged from communicating his or her idea to industry. After developing the plan, industry must police the plan to see that it works and works progressively more effective each year in promoting and encouraging people to think and to create as individuals.

—Kenneth K. Knopf
Hillsborough, Calif.

Axial, Not Radial

To the Editor:

We want to call to your attention an apparent misconception regarding the Indox V Magnetic Pulley manufactured by our Stearns Magnetic Products division. In the Design Show report (Apr. 28, p. 48) "axial" instead of "radial" was used. This radial design was unattainable with Alnico V, and its use is a major selling point of our new pulley.

—Donald C. Lamm
The Indiana Steel Products Co.

MOLY NEWS

CLIMAX MOLYBDENUM CO. DIVISION • AMERICAN METAL CLIMAX, INC.

Climax Develops an Extremely Tough, Abrasion-resistant Chrome-Moly White Iron

New Alloy Proves Superior in Erosive Applications

A new martensitic white iron has proved exceptionally tough and resistant to abrasion. It's called Alloy 42. Its excellent combination of properties are related to its structure — which consists of hard chrome-moly carbides favorably distributed in a matrix of martensite plus retained austenite.

Tests indicate Alloy 42 is especially economical for parts subject to erosive wear: sand pumps, flotation impellers, sand classifier wear shoes, pug mill blades, brick mold liners and chute liners.

For example, heat-treated Alloy 42 impellers in a 5" sand pump handling coarsely ground taconite ore have already lasted over 1,000 hours. Previous impellers made of a 4.5% Ni, 1.5% Cr type of martensitic iron lasted only 350 to 400 hours.

Because of its toughness, Alloy 42 can also be used where moderate impacts would cause low alloy types of white iron to break or spall. And it may prove more economical than the soft rubber parts or linings now used in various abrasive applications. Its resistance to tearing by tramp coarse materials and chemical attacks by oils and other organic compounds is an obvious advantage.

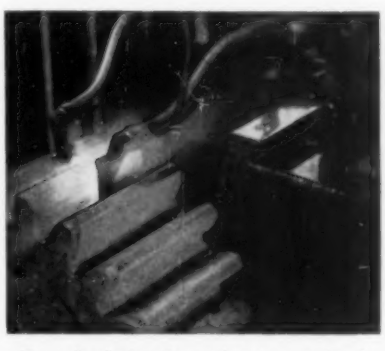
The recommended composition range is: Carbon 3.00-3.50%; Silicon 0.30-0.60; Manganese 0.60-0.90; Chromium 15.0-18.0; Molybdenum 2.75-3.25.

A Climax bulletin on Alloy 42 discusses melting and casting, molds and shrinkage, heat treatment, structure, physical properties, machinability, welding and cutting. *For a free copy, circle #1 on the coupon.*

Heat Treating Improves the Wear Resistance of Gray Iron

Heat treating can improve many of the properties of gray iron, particularly resistance to wear. Wear resistance in quenched-and-tempered gray iron is many times greater than that of pearlitic irons. With cams and similar parts, hot quenching provides better wear resistance than quenching and hardening to the same hardness. Surface hardening is frequently selected for gray iron because it locally improves wear resistance with minimum distortion.

Why Moly Iron Bulletin #6 contains valuable information on surface hardening, annealing and stress-relieving molybdenum-alloyed irons. This bulletin gives examples of improvements obtained by heat treating gears, cable drums, pump-ring castings, tappets, valve guides and machine tool ways.



Flame hardening the teeth on a sprocket improves wear resistance with minimum distortion.

*For a free copy of **"Why Moly Iron Bulletin #6,"** circle #2 on the coupon.*

Tempering Low-Alloy Creep-Resistant Steels

A recent British paper discusses the roles of chromium, molybdenum and vanadium in low-alloy steels with high creep strength. The relation between creep properties, microstructure changes and carbide composition is given special attention.

*For a copy of **"The Tempering of Low-alloy Creep-resistant Steels Containing Chromium, Molybdenum and Vanadium"** by E. Smith and J. Nutting, circle #6.*

Moly Helps High Alloys Fight Corrosive Attacks

Highly alloyed materials are playing a greater part in combating corrosion. A current paper on these alloys considers the molybdenum-bearing alloys at length and also discusses cobalt-base alloys and silicon-bearing alloys.

*For copies of this paper, **"High Alloys to Combat Corrosion"** by E. D. Weisert, circle #7.*

Thermenol Shows Excellent Resistance to Heat, Corrosion

Thermenol, an iron-aluminum-molybdenum magnetic alloy, compares favorably with other high-temperature materials, and in some cases promises even better service. For unlike many alloys, it doesn't lose tensile strength rapidly up to 1200 F. It also has excellent resistance to oxidizing and sulfur-bearing atmospheres at high temperatures.

*For a copy of **"Iron-aluminum Magnetic Alloy Has Excellent Heat Resistance,"** circle #8.*

Moly in Nickel-base Casting Alloys Improves High Temperature Service

Molybdenum is helping at least two nickel-base alloys to work more effectively in high temperature applications. One of the alloys, with 5% Mo, combines good castability with very good creep strength at temperatures up to 1800 F (much better than that of moly-free alloys). The second, with 10% Mo, shows high resistance to thermal shock.

*For free copies of **"Some Properties of Nickel-base Casting Alloys for High-temperature Service"** by D. R. Wood and J. F. Gregg, circle #3.*

Cast Steels Studied at Low Temperatures

The British Steel Castings Research Association has completed new studies on the effect of melting practice, composition and treatment of steel castings. Five of the seven alloy steels investigated contained molybdenum. The benefits of using molybdenum in low alloy steel castings for low temperature service are clearly shown in comparisons of 1.5% Mn and 1.5% Mn-Mo.

*For reprints of **"The Low-temperature Impact Properties of Cast Steel"** by W. J. Jackson and G. M. Michie, circle #4.*

New Data Available on Low Carbon Bainitic Steels

Studies have been made on new steels based on boron-0.5% Mo. Tensile strengths up to 180,000 psi can now be obtained within the bainitic range with a wide range of cooling rates. Thus these low-carbon bainitic steels offer a good combination of mechanical properties as-rolled or as-air-cooled. These properties can be obtained in large sections because hardenability is high. Good welding properties and tempering characteristics make the steels especially suitable as high-strength weldable steels, forgings, die blocks, etc.

*For copies of **"Low-carbon Bainitic Steels"** by K. J. Irvine and F. B. Pickering, circle #5.*

Climax Molybdenum Co. Division, Dept. 61
American Metal Climax, Inc.
500 Fifth Avenue, New York 36, N. Y.

I'd like more information on:
1 2 3 4 5 6 7 8

Name_____

Company_____

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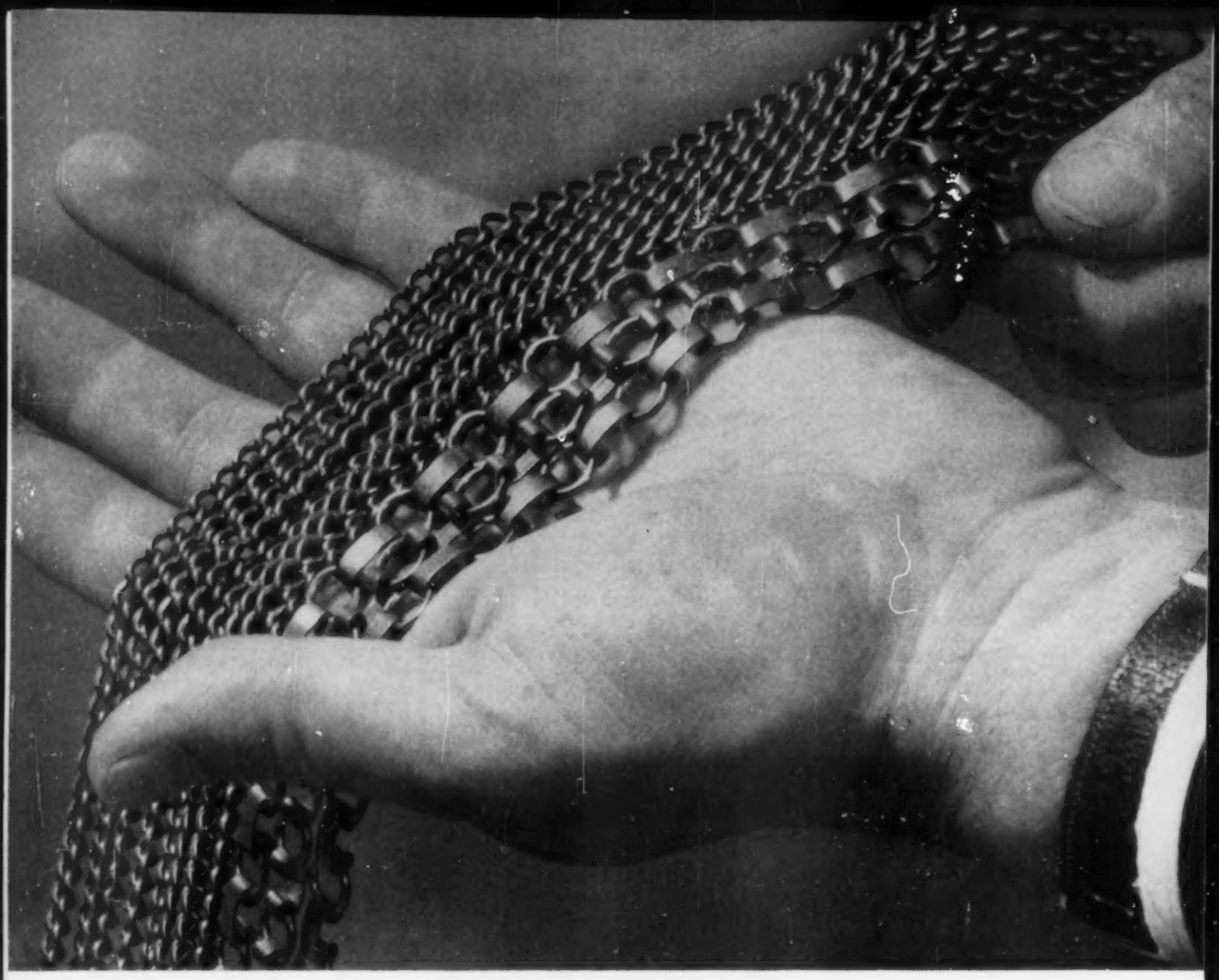


This jewelry chain of **COPPERPLY®** wire might give you a gem of an idea!

• Copperply wire, a National-Standard development, is a steel wire, electroplated with copper to required thickness and with unmatched coating uniformity and concentricity.

It makes sense for jewelry chain manufacturers to use Copperply wire instead of copper or brass wire, because material costs are greatly reduced. It also provides an ideal base for plating if desired, it excells in strength, and provides more footage per pound with resultant production and handling economies.

To date other uses in light coating weights include: wrapping for piano wires, reinforcement for eyeglass temples, decorative tinsel, fanning mill cloth, and springs where a combination of power and electrical conductivity is needed. A major use in heavy coating weights is in the field of communications.

Here we touch only briefly on a few of the unique Copperply features, but perhaps enough to spark an idea worth exploring. And you'll find that the word "cooperation" has real meaning at National-Standard . . . whether your interest lies in Copperply wire or any of our other products. **Try us.**

NATIONAL NS NATIONAL-STANDARD Company **STANDARD**

DIVISIONS: NATIONAL-STANDARD, Niles, Mich.; *fine wire, stainless, music spring and plated wires* • WORCESTER WIRE WORKS, Worcester, Mass.; *music spring, stainless and plated wires, high and low carbon specialties*
WAGNER LITHO MACHINERY, Secaucus, N. J.; *metal decorating equipment* • ATHENIA STEEL, Clifton, N. J.; *flat, high carbon spring steels* • REYNOLDS WIRE, Dixon, Ill.; *industrial wire cloth*

NEW OHMITE®

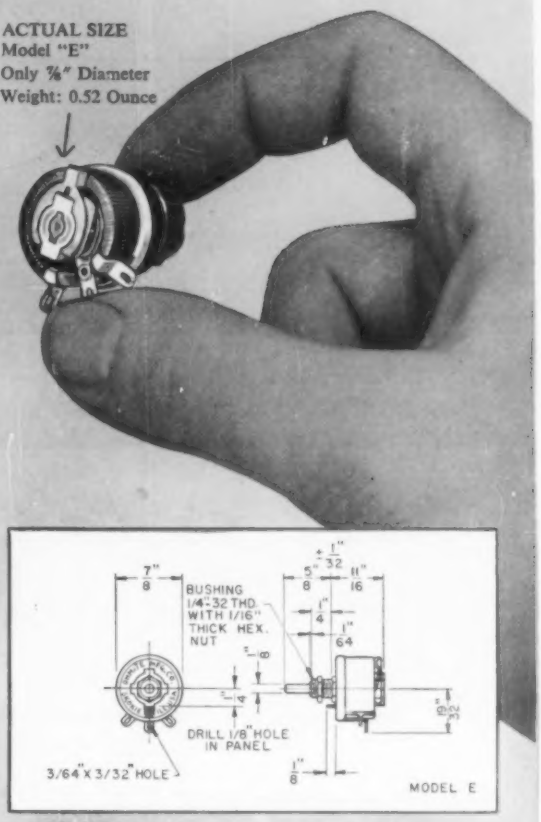
12½ WATT MINIATURE RHEOSTAT

High power handling capability for small size

Newest addition to the Ohmite line of vitreous-enameled rheostats is the new Model "E" miniature 12½-watt rheostat. This new unit is smaller than many one- or two-watt potentiometers. It provides time-tested Ohmite all-ceramic and metal design features for uses where as much as 12½-watt dissipation is required and space is extremely limited. Built to operate at a maximum hot spot temperature rise of 300° C at an ambient of 40° C, Model "E" is also useful for operation at high military ambients, derated linearly to zero at 340° C, attained. Rugged, lasting, power rheostat performance is thus available in such small size that new possibilities in miniaturization and dependability are afforded the apparatus designer.

Like the larger Ohmite rheostats, Model "E" has a ceramic base, and ring-shaped ceramic core. Vitreous enamel holds the turns of wire against shifting, and fastens the base and core together. Also, the Model "E" has a ceramic hub insulating the shaft; a metal-graphite contact; folded spring arm; independent compression spring; slip-ring; a stop directly connected to the shaft. The entire assembly is a miniaturized, dependable version of the time-proven Ohmite power rheostat design. Mounting is by a ¼"—32 threaded bushing. The shaft is ⅛" in diameter. Resistance range: up to 5,000 ohms with 23 stock values; higher values available with OHMICONE inorganic coating. Resistance tolerance: ±10%. Torque: 0.1 to 0.2 pound-inch. A small finger-grip knob, in keeping with the rheostat dimensions, is available.

Special length shafts and bushings, screwdriver shafts, locking type bushing, tandem mountings, enclosures, etc., similar to the variations available on the larger rheostat, can be provided upon specific request.



INDUSTRY'S MOST COMPLETE LINE OF RHEOSTATS

Now 11 Sizes! — 12½ to 1000 Watts

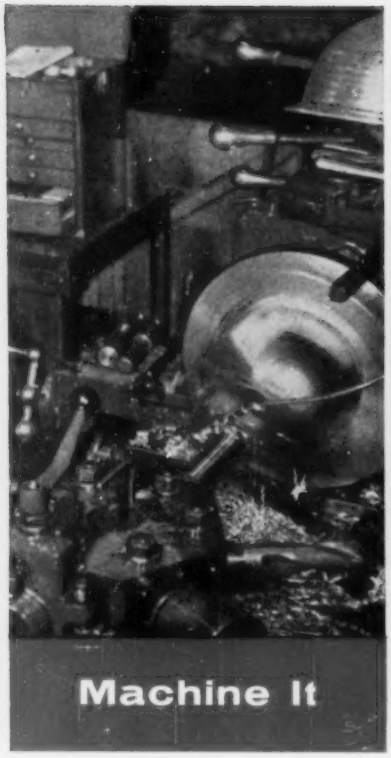
All sizes available from stock in a wide range of resistance values, including the NEW Model "E." Ten sizes are available to meet MIL-R-22A requirements in *each* of the 26 type designations.

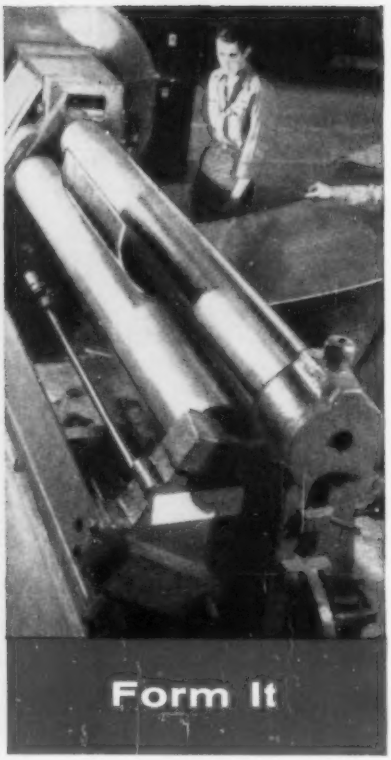
RHEOSTATS RESISTORS RELAYS
TAP SWITCHES TANTALUM CAPACITORS
R. F. CHOKES VARIABLE TRANSFORMERS

OHMITE® QUALITY Components

WRITE FOR BULLETIN 157

OHMITE MANUFACTURING COMPANY 3611 Howard Street, Skokie, Illinois





ALUMINUM... *Design-able*

"Aluminum is one of the most design-able of metals." So says the aluminum industry, naturally—but more and more product engineers and designers are adding their "amen" every year, by designing in aluminum.

Reason for aluminum's design flexibility is its *workability*. From a production standpoint, you can do more with this lightweight, strong, rustfree metal than any other commonly-used material, and production is often more efficient with aluminum.

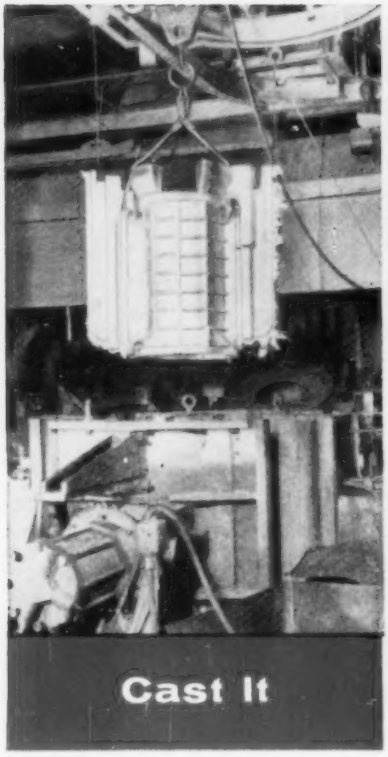
You can machine aluminum: Most aluminum alloys are known for their inherently good machinability. They cut easily at high speeds, saving time. They require less machine energy, saving power. They conduct heat away from the tool point rapidly, saving tool wear.

You can extrude aluminum: Aluminum can be squeezed through extruding dies to produce tailored shapes of almost unlimited variety. An extrusion, besides giving you wide design latitude, can often eliminate extra operations such as joining, machining, reinforcing or crimping. One extrusion often can replace several separate parts.

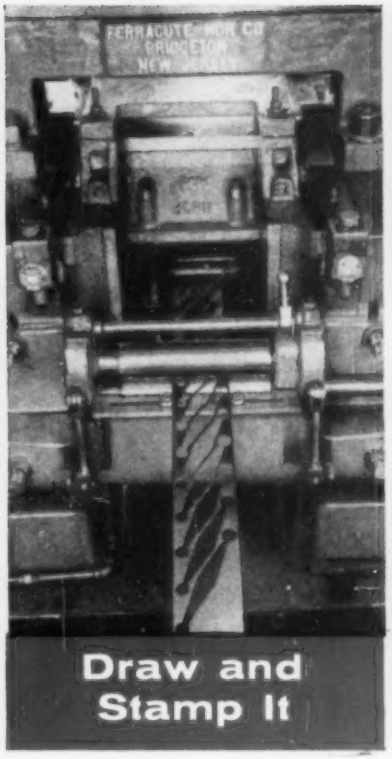
You can draw and form aluminum: Lightweight, ductile aluminum alloys are ideal for drawing and forming operations of all kinds. They'll draw and form easily, on standard equipment—and often require less power.

You can cast aluminum: Aluminum can be easily cast by all three methods: sand, permanent mold and pressure die casting. It can be cast in thinner sections than most materials,

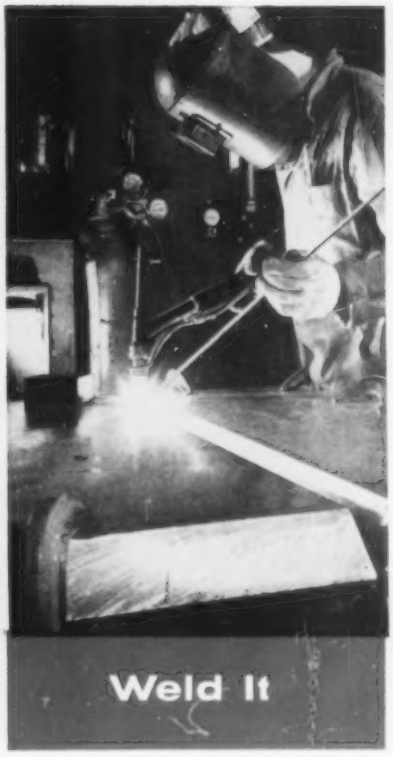
REYNOLDS



Cast It



Draw and Stamp It



Weld It

because it's workable

and produces a casting which requires much less (if any) machining or finishing treatment. Aluminum castings usually cost less than ferrous castings, when you consider finishing costs, handling costs, and metal costs.

You can stamp aluminum: Aluminum can be used to efficiently produce stampings, punchings or blanks . . . and tools last longer when stamping aluminum. It's lightweight and easy to handle, often needs less finishing.

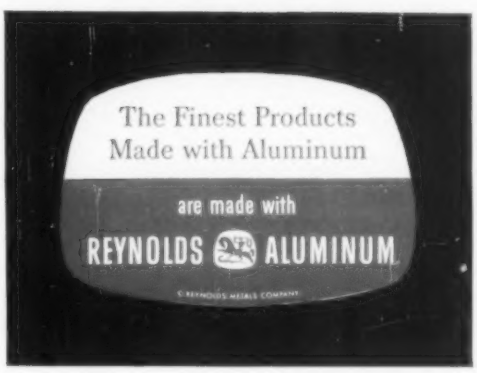
You can weld aluminum: Any of the common joining methods—welding, brazing, riveting, even soldering—are practical with aluminum. In addition to the popular inert gas arc weldings, all other common welding methods can be used with aluminum.

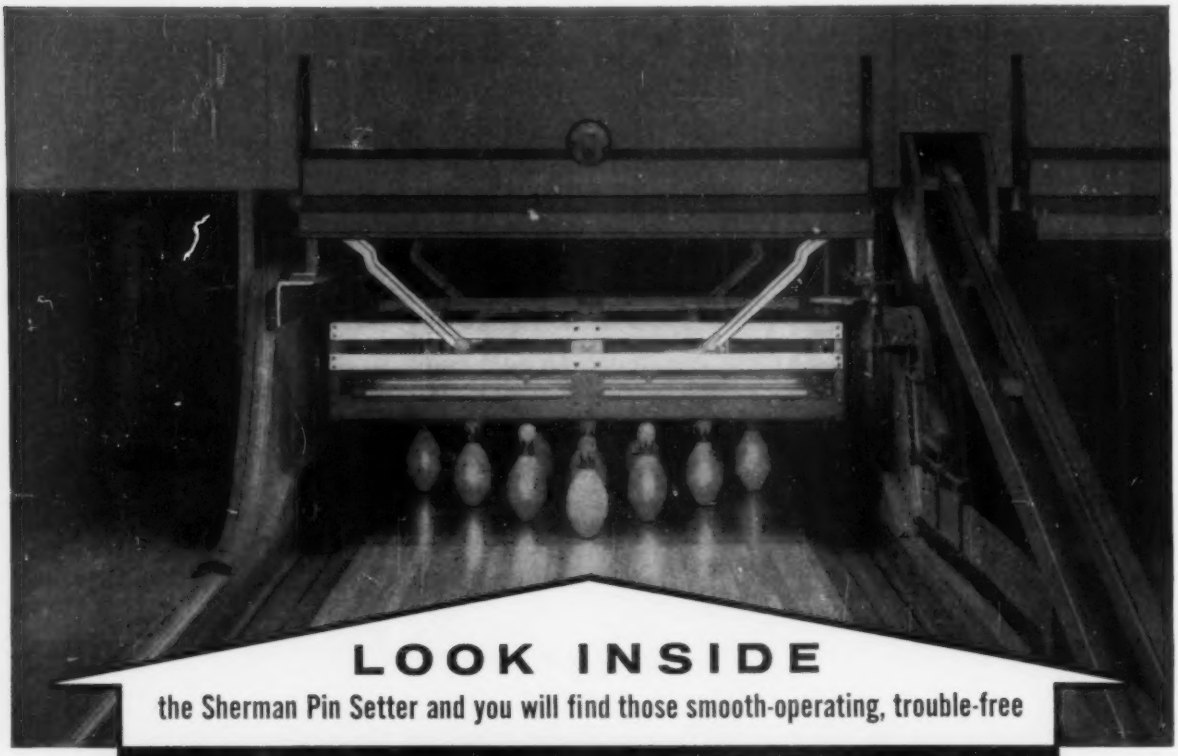
Take advantage of the versatility, the workability of aluminum. It's one metal that can improve products, and cut production costs, too. For full information on the potentials and characteristics of the various aluminum alloys—or for technical assistance—contact Reynolds Design and Engineering Services through your local Reynolds office.

Reynolds Metals Company, P.O. Box 2346-HN, Richmond 18, Virginia.

ALUMINUM

Watch Reynolds All-Family Television Program, "DISNEYLAND", ABC-TV.





LOOK INSIDE

the Sherman Pin Setter and you will find those smooth-operating, trouble-free

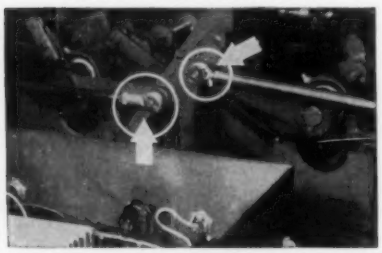
HEIM *Unibal*® ROD ENDS

Bowlers like duckpins at all hours of the day — times when pinboys are not always available. The Sherman Pin Spotter is an automatic device for setting the pins on their spots, sweeping the alley clear of deadwood, replacing remaining pins for next shot, and returning balls for next frame. These pin setters, presently made by Crompton & Knowles Corp., must be ready to operate at all times at the push of a button.

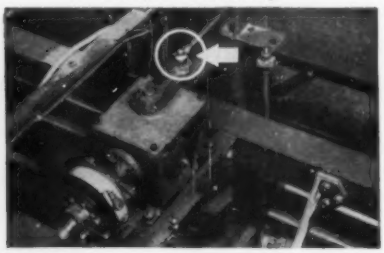
Photos taken at Johnson's Bowling Academy, Hamden, Conn.

HEIM UNIBAL ROD ENDS contribute trouble-free dependability to the push-pull rods on the distributor table drive assembly, and carry the full thrust load of the sweep drive assembly (the swinging arm which sweeps the alley clear of deadwood).

Distributor table drive assembly.



Sweep drive assembly.



If you could look inside any equipment where power/motion is being transmitted at varying angles, you would find the Heim Unibal being used in more and more applications. It is the original Spherical Bearing developed, engineered, and manufactured by The Heim Company for over fifteen years.

Load ratings, specifications, and sizes are all shown in the complete catalog of Heim bearings. Write for copy, and for any special engineering data.

THE HEIM COMPANY

FAIRFIELD, CONNECTICUT

MINUTEMAN!

Your steel service center starts delivery even as you place your order!

In every way, your local steel distributor is geared to keeping production lines rolling.

He's ready to rush the amount, quality, size and shape of steel to meet almost any conceivable demand—on the double. He's your on-the-spot insurance against the plant shutdowns and lost contracts that can be caused by in-plant steel shortages.

On a regular basis, his facilities, stocks and fast delivery service can be integrated with your production needs. He is, truly, the service center of the steel industry. And he's only a phone call away.

Call him for any quantity of Weirkote continuous-process zinc-coated sheets, Weirzin electrolytic zinc-coated sheets, hot- or cold-rolled sheets or any type of steel you may need for any type of production job.

CIRCLE 119 READER SERVICE CARD

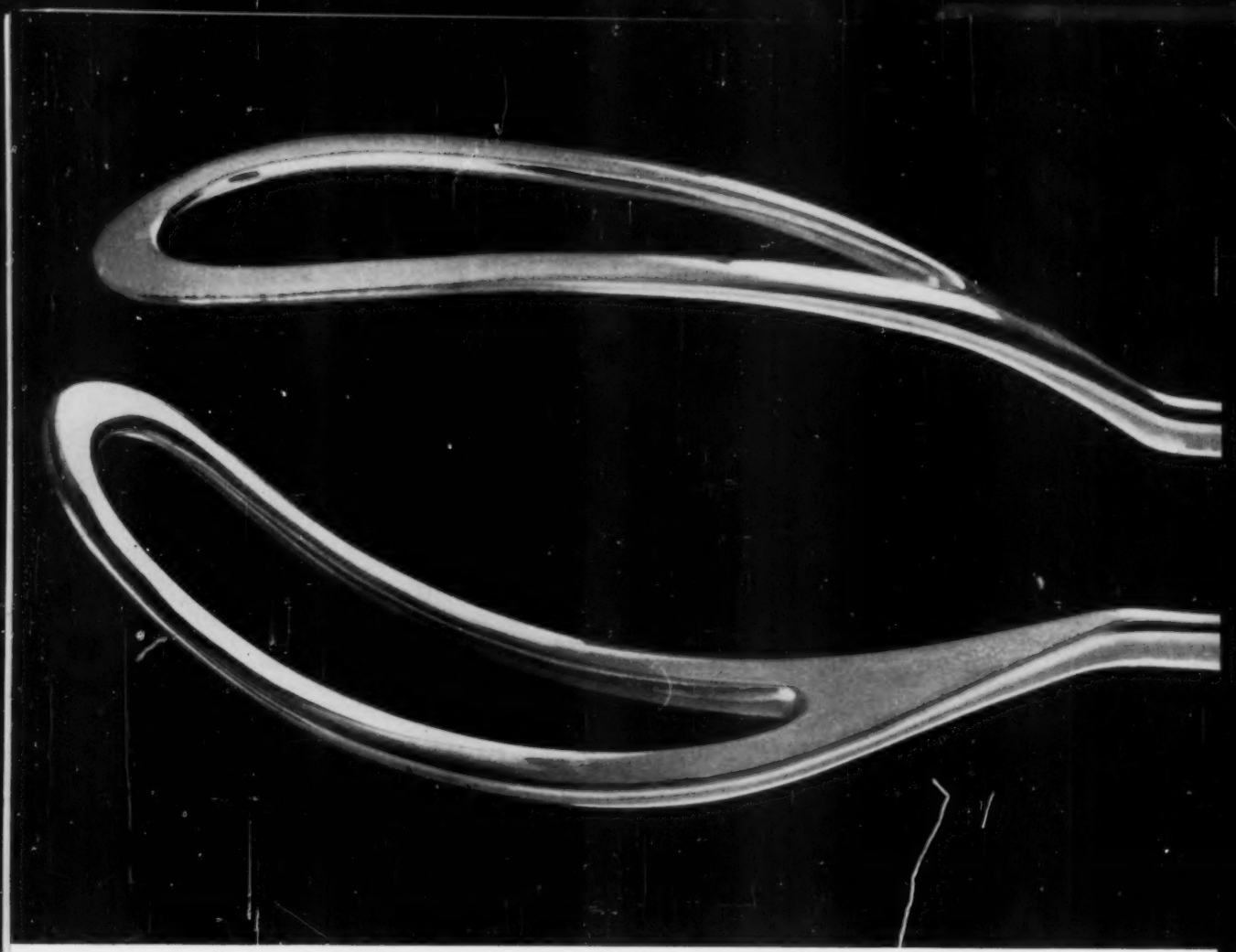
WEIRTON STEEL COMPANY

WEIRTON STEEL COMPANY

WEIRTON, WEST VIRGINIA

a division of

NATIONAL STEEL CORPORATION



Corrosion Resistance It is an immutable law of Nature that all things seek their most stable state. Nitroglycerine craves opportunity to explode back into passive water and gas vapor. Radium glows silently as it decays into lead. Metals yearn to return to their oxides.

Corrosion is simply the return of a metal to its most stable form. It's an electrochemical process that is generally speeded up by the presence of salts, acids and moisture—in fact, at humidities below 50% there is virtually no atmospheric corrosion of steel. There are six common ways to minimize corrosion: select the right steel, apply protective coatings, install cathodic protection devices, set up periodic cleaning procedures, control the corrosive environment, and use *design* techniques which reduce the cost or likelihood of corrosion.

We have a record of one case where a manufacturer installed expensive piping to transport gaseous chemicals—overlooking the fact that ordinary carbon steel pipe would do the job just as well *if it were insulated* to prevent condensation of the chemicals inside the pipe. Sometimes a vessel is designed with great care so that it will hold a corrosive liquid, only to have the vessel attacked from the *outside* because the support brackets harbored pockets of moisture. And there are cases on record of stress corrosion failure because it was not recognized that stress relieving was necessary after cold working the metal.

Empirical corrosion information can be an excellent guide, but actual service records or true-to-life tests are the safest ways to judge a grade of steel, and you can often avoid the expense and time-consuming nature of making your own tests if you check first with United States Steel. A corrosion problem that is new to you may be familiar to us, and we may be able to supply you with information that will solve your particular problem promptly.

Another good reason for coming to United States Steel is this: no matter what kind of steel you need, you're sure to find it among the vast range of USS Steels for Design. The final selection, of course, should be made by a skilled metallurgist. Our technical staff is always available to consult with you about your problems. United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

USS, COR-TEN, TRI-TEN and "T-1" are registered trademarks

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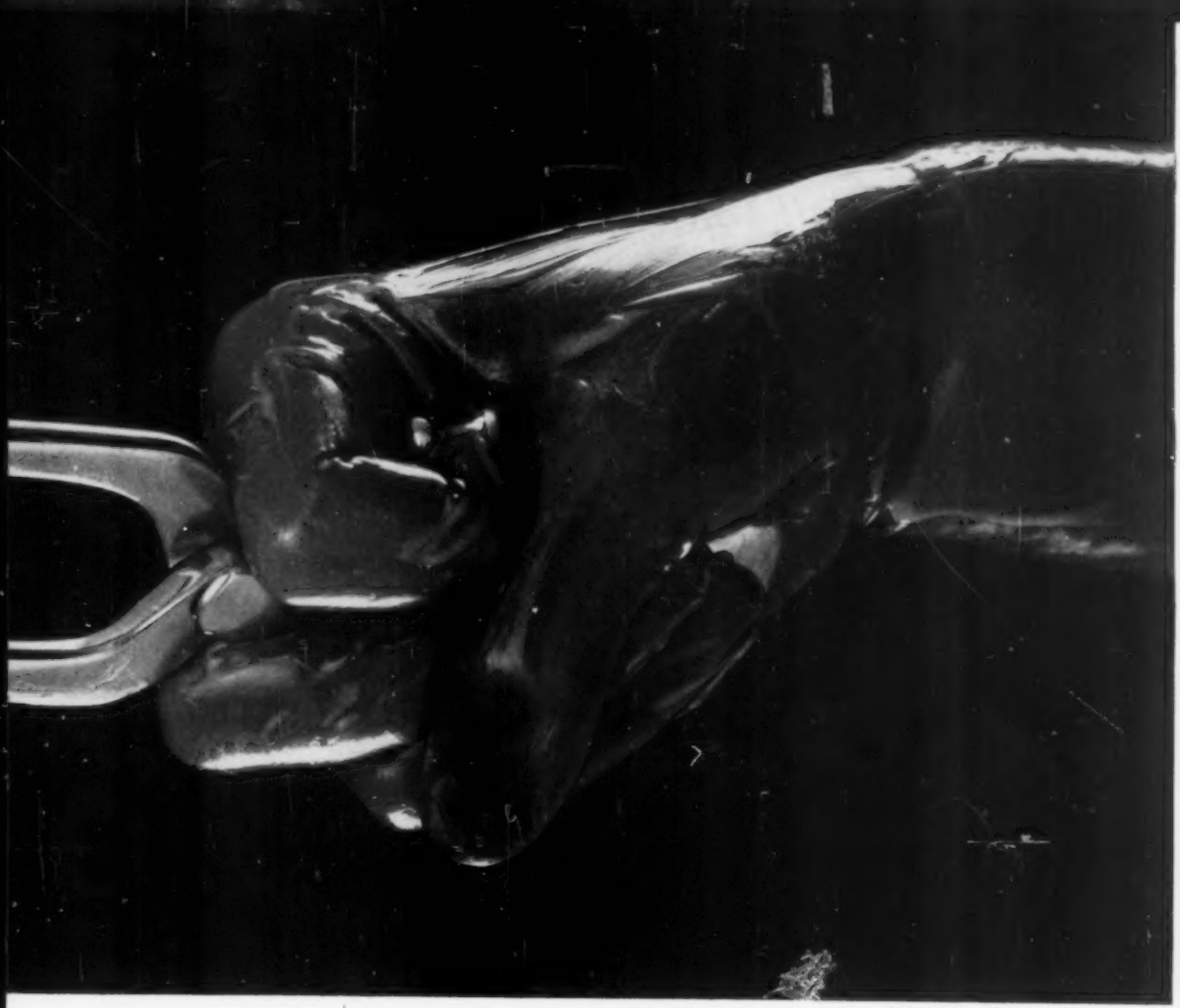
Tennessee Coal & Iron • United States Steel Supply • United States Steel Export Company

USS **United States Steel**

STEELS FOR DESIGN

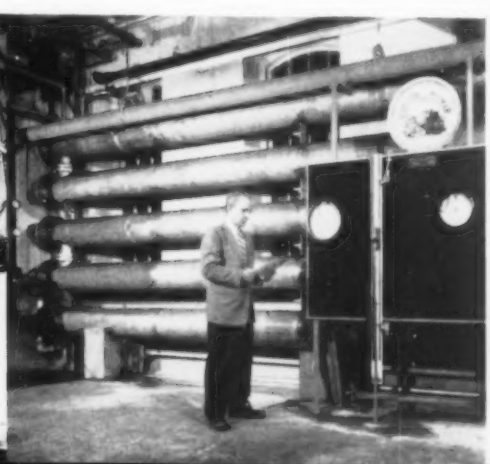


Stainless Steel obstetrical forceps

Lower Left—Problem: The City of Pittsburgh wanted a trouble-free hull on their new, all-steel fireboat. Solution: Paasch Marine Service built the hull with ¼" USS COR-TEN High-Strength Low-Alloy Steel. Payoff: A light, strong hull that has four to six times the atmospheric corrosion resistance of carbon steel plus superior paint adherence.

Lower Middle—Problem: Combat corrosion in the new Carquinez Strait Bridge by designing smooth, welded members eliminating details vulnerable to corrosion. Solution: USS "T-1" Constructional Alloy Steel and USS TRI-TEN High-Strength Low-Alloy Steel, both weldable and both having superior resistance to atmospheric corrosion. Payoff: The smooth, welded framework will assure much lower maintenance costs than the annual $70,000 needed to paint and maintain the old, riveted bridge. (And a bonus advantage: "T-1" Steel's high yield strength permitted strong, lightweight design, saving $800,000 in over-all cost.)

Lower Right—Problem: Design a preheating unit for a textile plant to handle hot water with a highly corrosive caustic soda content. Solution: 19,000 lineal feet of Type 304 Stainless Steel tubing inside the Stainless shells. Payoff: Ludell Manufacturing Company predicts that the unit will last indefinitely.

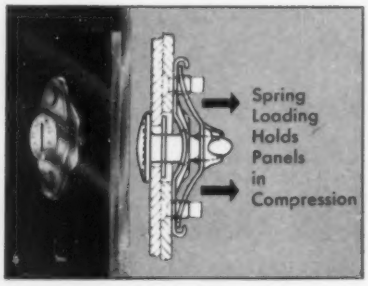


Quick-Opening Fasteners

Selecting Small Fastenings for Metal Closures

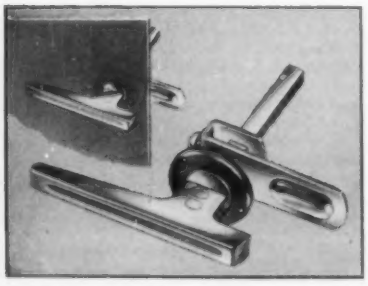
*"Use captive fasteners wherever feasible . . . Avoid the use of loose washers and loose nuts . . . Fasteners on equipment covers should be operable either with no tools or with standard hand tools"**

(John D. Folley, Jr. & James W. Altman, Research Scientists, American Institutes for Research)



Quarter-Turn Fastener

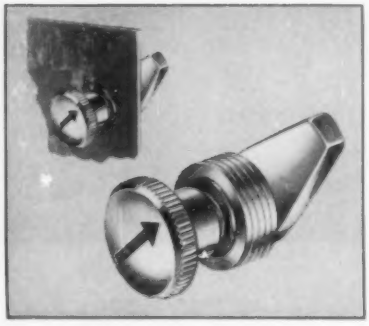
Lion Fasteners open and close with a ¼ turn, hold sheets tightly under the compression of a rugged spring. Quickly operated and fully retained in the outer panel, they are approved under U. S. Government military specifications. Stud and receptacle float for easy alignment and simplified hole preparation. Flush, oval, wing, knurled, ring, and key head styles available. Sizes—No. 2, No. 5, and High Strength for extra heavy duty.



Cabinet Latch

Just drill a hole, push the fastener stem through, and slide the special push-on clip into place. No welds, screws, bolts or rivets: the fastener is permanently installed in seconds!

Adjustable to any grip length or panel thickness, the pawl is fixed in place by a single set screw. The fastener's brightly finished knob is set off by a plated washer. Also furnished with screwdriver operated flush head.

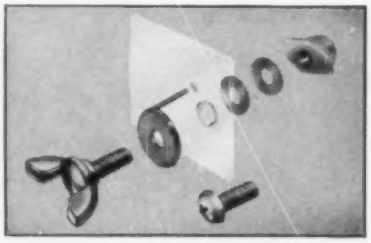


Spring Tension Latch

For fastening slide-out drawers and hinged panels the Southco Arrowhead Latch is recommended. It locks or opens with a quarter turn yet occupies less than ½" inside space.

Doors are held under spring tension—a push against the arrowhead knob relaxes this tension, allows operation with fingertip ease. Drill a single hole for installation—no fastening to the door is necessary. No striker plate is needed.

Pawl stop is eliminated—arrowhead shows at a glance exact position of pawl.



Adjustable Panel Latch

Small doors and panels can be fastened with greatest speed and lowest cost with the Southco Adjustable Latch.

The entire fastener is quickly installed through two holes punched in the door; no bolts or rivets are needed.

It operates with a quarter turn, requires no striker plate. An extra twist after the nylon pawl is engaged pulls up the door to form a seal and eliminate vibration.

Available with wing, knurled, or Phillips head.

Free Fastener Handbook

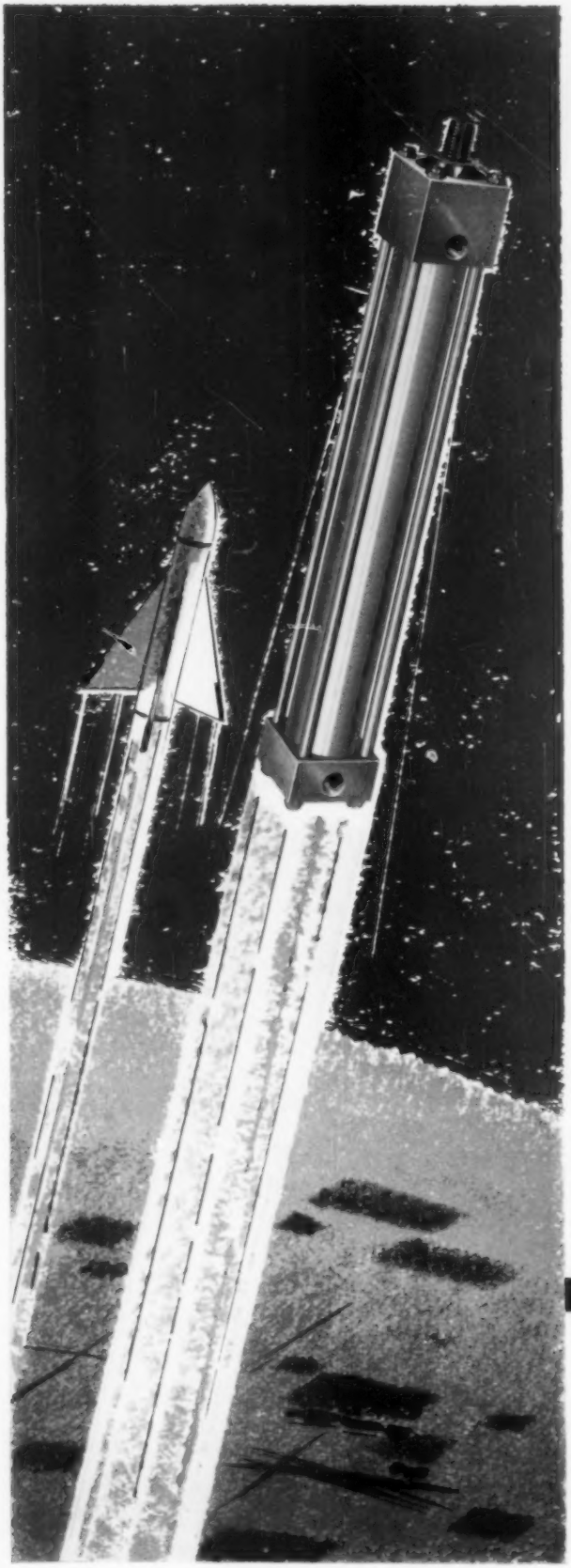
Send for your free copy of Fastener Handbook No. 8, just released. Gives complete engineering data on these and many other special fasteners. 48 pages, in two colors.

Write on your letterhead to Southco Division, South Chester Corporation, 236 Industrial Highway, Lester, Pa.

SOUTHCO FASTENERS
LION

© 1956

* *Quotation from "Designing Electronic Equipment for Maintainability"; Machine Design, July 12, 1956.*



ORTMAN-MILLER Launches Another Star Performer... The O-M Automation

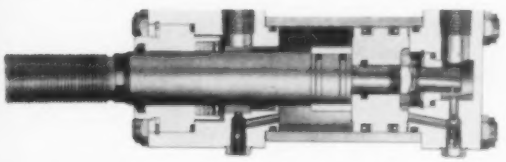
Heavy-Duty Air and Hydraulic Cylinders

1000 PSI Hydraulic — Series RH

200 PSI Air — Series RA

available in 1½" to 8" bores

Meets JIC and Automotive Industry "Automation Standards"



Any resemblance between a guided missile and an O-M AUTOMATION cylinder is purely coincidental. However, each stands as a symbol of progress in its own field.

In the Series RA and RH air and hydraulic cylinders O-M has incorporated many advanced features in an extremely rugged line of cylinders designed to meet automotive industry specifications for Automation cylinders. The advanced design of these cylinders makes them well suited for severe applications in all types of machinery and equipment.

For detailed information, consult your local O-M representative or see our new catalogues No. 107 for Air Cylinders— No. 108 for Hydraulic Cylinders.

Mail coupon below for your copy!

ORTMAN-MILLER MACHINE COMPANY

15 143rd Street, Hammond, Indiana

☐ Have representative call

☐ Send Bulletins 107 and 108

Name_____ Position_____

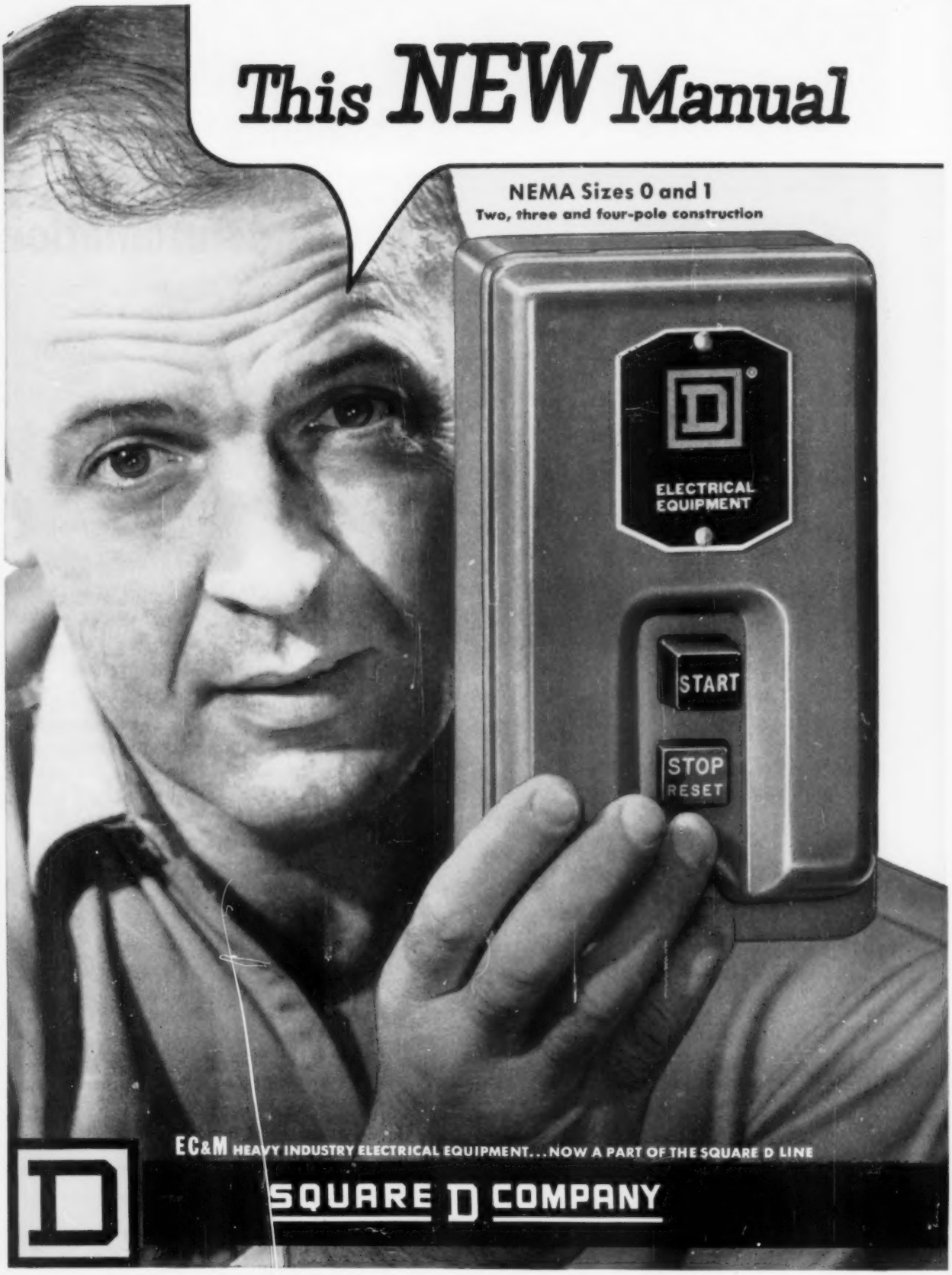
Company_____

Address_____

City_____ Zone____ State_____

This NEW Manual

NEMA Sizes 0 and 1
Two, three and four-pole construction



EC&M HEAVY INDUSTRY ELECTRICAL EQUIPMENT... NOW A PART OF THE SQUARE D LINE

SQUARE D COMPANY

Starter has EVERYTHING!

SMALLER!
Takes less space, whether it's built into machine or mounted externally

SMART STYLING!
Matches the streamlined appearance of today's modern machines

QWIK-MAKE, QWIK-BREAK!
Positive snap action opening and closing of contacts. Longer contact life

TRIP-FREE OVERLOAD PROTECTION!
Impossible for operator to hold motor circuit closed against overload

LONGER LIFE!
Toggle Action operating mechanism. Heavy duty construction throughout

EASIER INSTALLATION!
Wire it without removing starter from enclosure. All terminals have pressure wire connectors

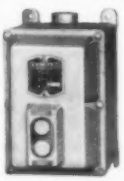
EASIER MAINTENANCE!
"Off-the-Shelf" parts kits make normal maintenance and modifications easier than ever. They're easy to buy, easy to identify, and faster to install

TAMPER-PROOF!
Cover padlocking device prevents tampering by unauthorized personnel. Safety latch locks "start" button in "OFF" position

VISIBLE INDICATION OF OVERLOAD!
Self-centering pushbuttons show when overload has occurred

CHOICE OF ENCLOSURES

Water and Dust-Tight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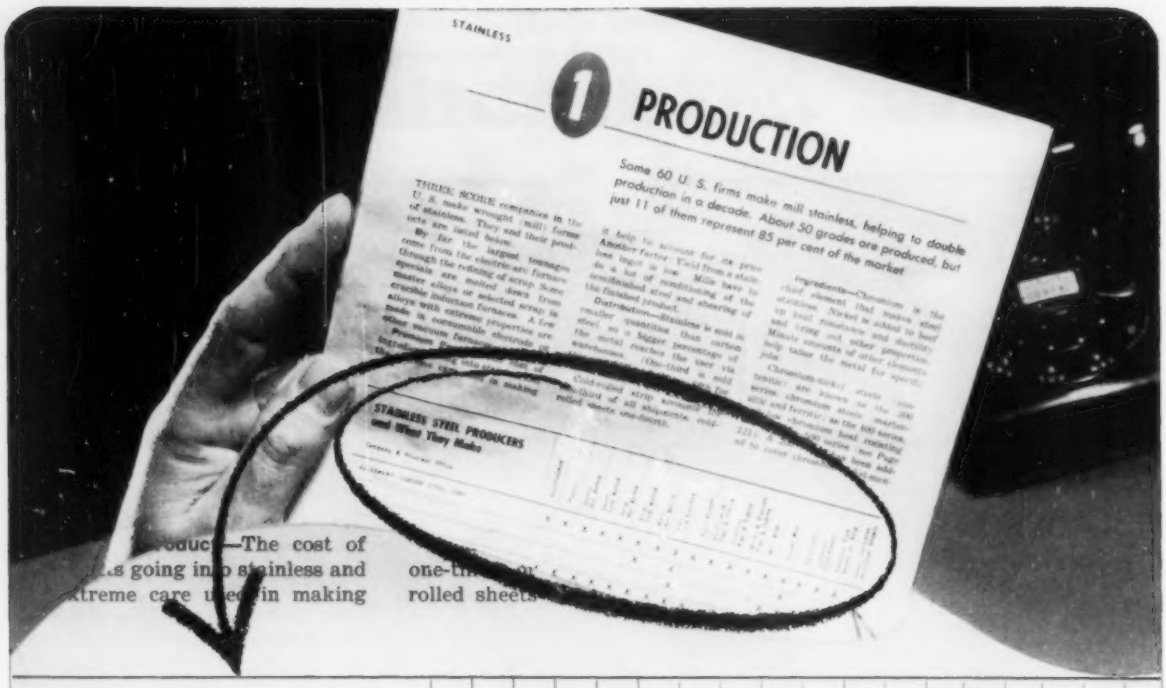
STAINLESS
1
PRODUCTION
Some 60 U. S. firms make, mill stainless, helping to double production in a decade. About 50 grades are produced, but just 11 of them represent 85 per cent of the market
STAINLESS STEEL PRODUCERS and What They Make

STAINLESS STEEL PRODUCERS and What They Make Company & Principal Office	Semifinished	Plates	Sheets, Hot Rolled	Sheets, Cold Rolled	Strip, Hot Rolled	Strip, Cold Rolled	Bars, Hot Rolled	Bars, Cold Finished	Tube Rounds	Electricweld Pipe & Tubing	Seamless Pipe & Tubing	Mech. & Pressure Pipe & Tubing	Wire Rods	Drawn Wire	Extrusions	Stainless Clad Plates	Stainless Clad Sheets or Strip	Other, Including Structural Shapes
ALLEGHENY LUDLUM STEEL CORP. Pittsburgh	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
[illegible]						X		X						X				

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In its November 4, 1957 issue, STEEL magazine published a complete run-down on the stainless steel industry. This article reveals that *only Allegheny Ludlum*, of the 60 some companies making stainless, produces all sizes, shapes, finishes and analyses.

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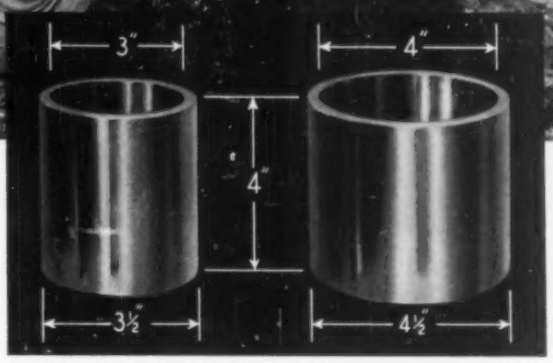

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Porosity, %	18-23
Ultimate Tensile Strength, (psi)	18,000
Compressive Strength (psi)	20,000
Elongation, % min. in 1"	10
Brinell Hardness	40

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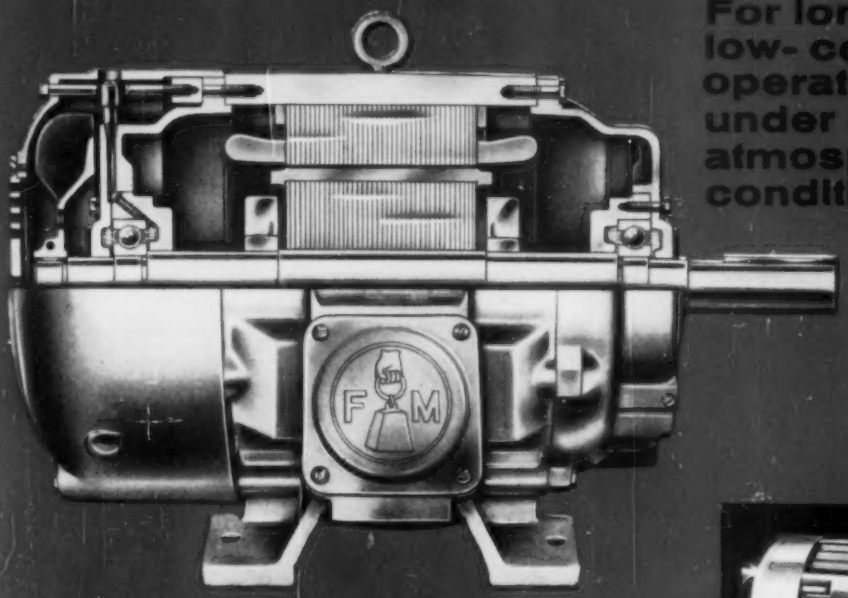

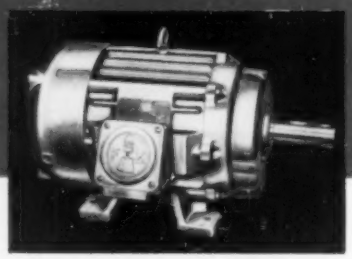

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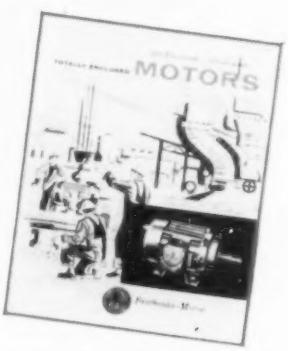
Fairbanks-Morse Totally-Enclosed Fan Cooled With Controlled-Stream Air Flow!

New Fairbanks-Morse design confines air stream to surface of motor—provides extremely efficient cooling, prevents dust and dirt accumulation. Combines advanced design innovations with long-proven F-M features.

See why these all-new F-M motors warrant your investigation *now* for severe service involving dirt, dust, metal turnings, or abrasive particles; corrosive vapors, steam, excessive moisture, etc.

Write today for new Bulletin 1205, giving complete information on new F-M Totally-Enclosed Fan-Cooled (Type KZC, in larger frames) and Non-Ventilated Motors (Type KZE, in smaller ratings). Fairbanks, Morse & Co., 600 So. Michigan Ave., Chicago 5, Ill.



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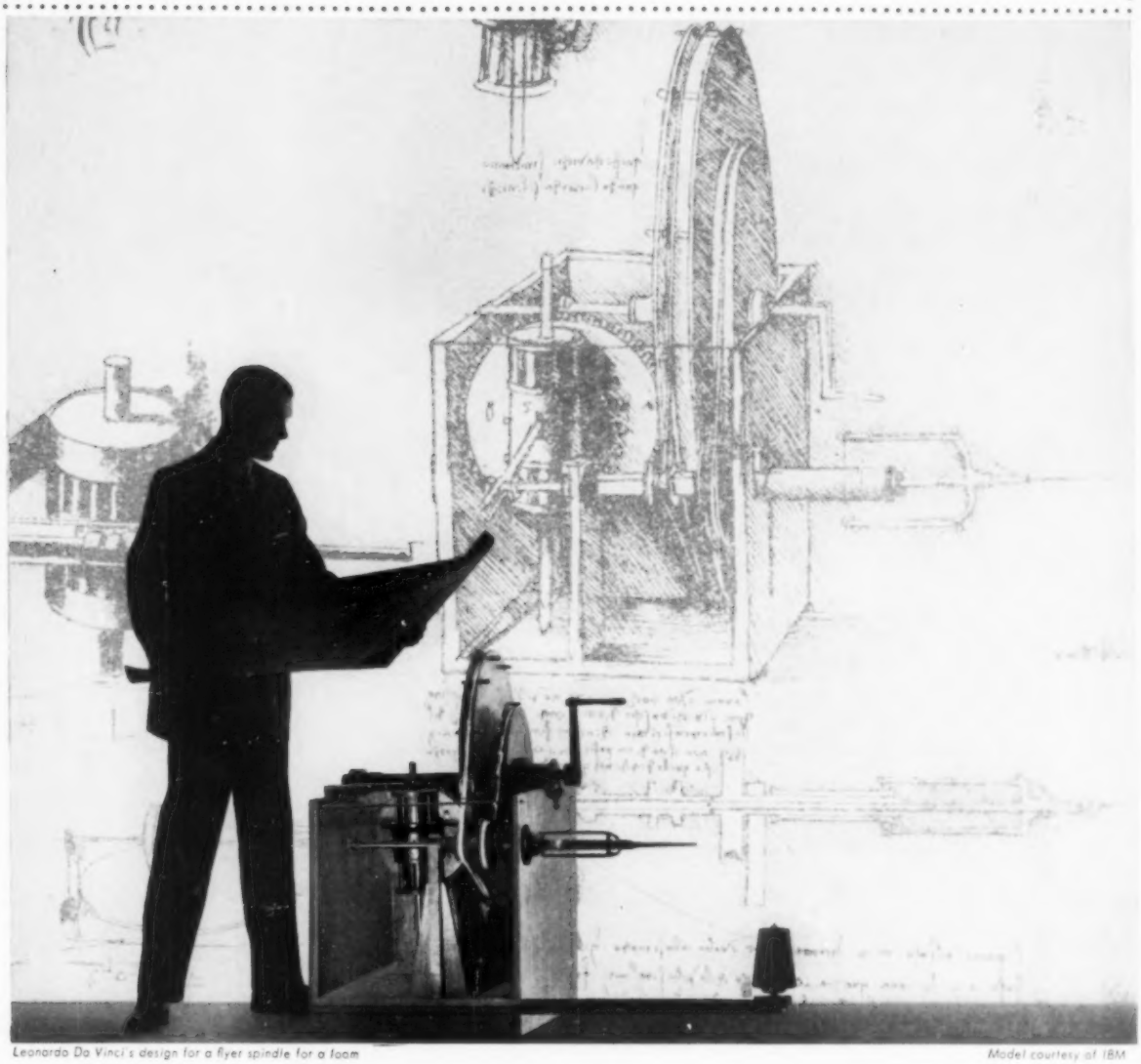
creative designing calls for an open mind



Leonardo Da Vinci's design for a flyer spindle for a loom — *Model courtesy of IBM*

EVEN DA VINCI'S DESIGN COULD HAVE BEEN BETTER WITH HELP FROM AN SKF ENGINEER—An SKF engineer never has to push one bearing over another, because SKF makes all four types of ball and roller bearings in over 3,000 sizes. This gives every SKF engineer the kind of flexibility he needs to keep an open mind on *any* bearing problem. Give your problem to SKF and see.

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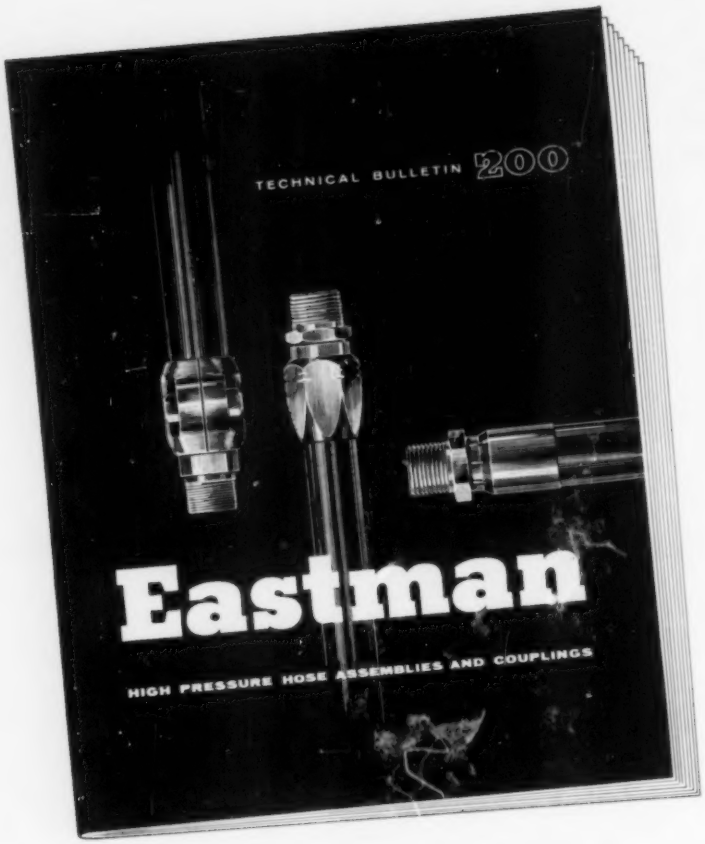

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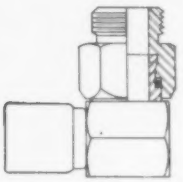
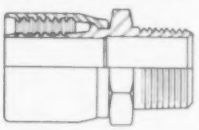
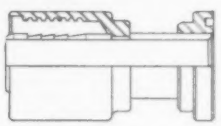
Eastman's new Technical Bulletin offers a new standard in simplified arrangement—for your convenience in specifying—according to your pressure requirements.



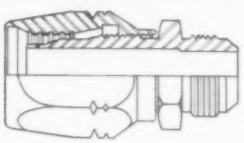
Swivel "O" Ring Male Couplings are available in 45° and 90° angles. Specifications on Page 13.



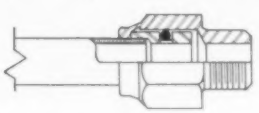
Permanently Attached Couplings for 2-wire braid hose. Specifications and Details on Page 10.



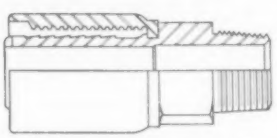
Permanently Attached Flange Head Couplings and Inserts from 0° to 90°. See complete list on Page 21.



2-Piece Reusable Couplings for all high pressure hose. Used for pressures up to 5000 lbs. See Page 25.



Swivel Male Tube Nut "O" Ring Assembly used on formed tubing—described on Page 30.



Permanently Attached Couplings for **Extreme** High Pressures up to 7000 lbs. working pressure, Page 12.

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Molders across the nation rely on Dow Vinyltoluene and Dow Styrene for top-quality premix moldings. They can help you to better products at lower costs. For the names of molders and suppliers, contact your nearest Dow Sales office or write to THE DOW CHEMICAL COMPANY, Midland, Michigan, Plastics Sales Dept. 2206K.

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DESIGNING WITH ALUMINUM

NO. 28

This is one of a series of information sheets that discuss the properties of aluminum and its alloys with relation to design. Extra or missing copies of the series supplied on request. Address: Advertising Dept., Kaiser Aluminum & Chemical Sales, Inc., Department PD-1, 919 N. Michigan Ave., Chicago 11, Ill.

CLEANING AND PROTECTING ALUMINUM SURFACES

To aid designers in recommending maintenance procedures for aluminum finishes, this article summarizes the recommended uses and methods of applying mechanical, chemical, proprietary and wax-lacquer materials.

THE SUBJECT of cleaning and maintaining aluminum is a departure from the usual content of this design series. But with the growing importance of *product finish*, the designer today is as much concerned with lasting beauty as with development of a product itself.

Four Types of Maintenance

In general, the methods and materials for cleaning and protecting aluminum surfaces may be divided into four groups or types: mechanical cleaning, chemical cleaning, treatment with cleaner-wax-polishes, and waxing or lacquering. In most cases, only one of these types will be required to return the aluminum to its original pleasing luster. In some instances, a combination of them may be necessary. As a rule of thumb, the mildest treatment that produces satisfactory results should be used.

The natural oxide film which is responsible for corrosion resistance forms rapidly on clean aluminum exposed to air. This self-healing action assures the natural corrosion resistance of aluminum within a short time after cleaning. An *anodized* aluminum surface is virtually impervious to atmospheric influences. However, should it be desirable to clean anodized aluminum, washing with a warm solution of a mild soap is usually all that is necessary. In the event that an exceptionally tenacious soil is encountered, a mild abrasive cleaner should be used.

1. MECHANICAL CLEANING

The simplest, and therefore the most common, method for removing dirt from aluminum surfaces is mechanical cleaning. Because of their action, soaps and detergents are included as cleaning agents under this group. Actually, many soiled aluminum structures and vehicles can be cleaned with nothing more than soap and water applied with a soft scrubbing brush. Strong detergent solutions, if not thoroughly rinsed, may cause surface staining. Rinse thoroughly, wipe dry with a clean cloth.

Mild abrasive cleansers—such as the household cleansing and scouring powders—are effective in cleaning aluminum. Application is made with a cloth dampened in water. Surface must be rinsed well and wiped dry. *Caution:* always work with the grain of the metal.

Steel wool—for harsher abrasion—must be carefully used on aluminum, rubbing in the direction of the metal grain and using only enough pressure to remove the soil. Heavy pressure will mar the mirror reflectivity of the surface. Special care must be taken with "satin" finished aluminum to prevent polishing of the etched satin finish. Stainless steel wool, 00 size or finer, is preferable for cleaning aluminum because it will not cause corrosion if slivers become embedded. If steel wool soap pads are used, the aluminum surface must be thoroughly rinsed to prevent rust discoloration from embedded slivers.

When using abrasives, always bear in mind that they may alter the appearance of the aluminum finish. To minimize such change, always rub in the direction of the finished grain—never across the grain. Special care should be exercised in cleaning matte finished aluminum which has no grain.

2. CHEMICAL CLEANING

The fastest and least expensive way to clean aluminum surfaces, especially large areas, is to use liquid chemical cleaners. These cleaners may be obtained ready-for-use or in a concentrated form that requires dilution with water or mineral spirits before application. Because they can be applied rapidly by swabbing or spraying, they have found ready acceptance in the aircraft and railroad industries.

Solvent cleaners—kerosene, turpentine and naphtha—are especially good for greasy deposits and for heavy accumulation of grime. It is a good practice to rinse off the solution to avoid streaks or deposits. If a surface has been lacquered, it may be cleaned with a mineral solvent or turpentine and a soft

When using abrasive cleaners of any kind, care must be taken to work with the grain of the aluminum surface to avoid marring mirror or satin finish.

Either paint-spray equipment or clean brushes may be used to apply protective lacquers. Before lacquering, surface should be prepared by etching-type cleaner.

cloth. A clean absorbent material should be used for drying. Non-etching type chemical cleaners—available under brand names in ready-to-use and in concentrated form—are the fastest and least expensive way to clean large aluminum areas.

Etching chemical cleaners—phosphoric acid type (*not* to be used on anodized aluminum)—are heavy duty cleaners to be used when all other methods fail. Etching chemical cleaners change the appearance of the finish and may permanently harm the aluminum surface unless thoroughly rinsed, especially out of cracks, corners and holes. Care should be exercised to see that there is no run-down on the aluminum outside the area being cleaned.

If cleaning is followed by waxing, a non-etching type cleaner is usually preferred. However, etching type chemical cleaners (generally having a phosphoric acid base) are most effective for surfaces that are subsequently lacquered. The degree of etching can be controlled somewhat by the length of time that the cleaner is left on the aluminum surface. Manufacturers' directions should be followed carefully when using chemical cleaners. Chemicals left too long in contact with the aluminum surface may have a corrosive effect. Therefore, rinsing must be liberal and thorough.

Steam is an excellent mild treatment for removing dirt, grease deposits and common atmospheric soil. If cleaning additives are used, strong alkaline solutions are to be avoided. Following steam cleaning, surface should be rinsed thoroughly with clean water and dried with a clean cloth. Make sure there is no collection of moisture at the bottom edges of the aluminum.

3. CLEANER-WAX-POLISHES

Using any of the proprietary cleaner-wax-polishes which are available requires somewhat more time than either mechanical or chemical cleaning. However, despite the greater labor, they are not difficult to apply. Furthermore, they provide a limited amount of surface protection, and thus may eliminate the need for a waxing operation if cleaning is to be done on a frequent schedule.

Wax-base polish cleaners should be applied with a clean, soft cloth as directed by the manufacturer. The thin protective coating need not be removed unless the aluminum surface is to be lacquered. Because of the wax content, these products should be applied indoors or in shade. When working with large objects, a mechanical buffer is of great assistance. Because of the mildness of the abrasive, this type of cleaner is one of the safest for use on aluminum. Non-wax-base polish cleaners—such as used for cleaning glass—are satisfactory for cleaning aluminum, and abrasive waxes of the type used for cleaning metal tableware are effective in removing atmospheric grime deposits.

4. PROTECTIVE WAXES AND LACQUERS

Unless aluminum structures or vehicles can be cleaned at regular, frequent intervals, the metal surfaces should be protected against the discoloring effects of severe environments or travel grime. Waxing is the cheapest and simplest way to do this. Suitable waxes are available in either paste or liquid form. Generally, waxed aluminum surfaces can be cleaned by merely wiping them with a damp cloth. They may be rewaxed over previous wax coats that have been cleaned, but in time this built-up coating will yellow. When this happens, the wax should be removed with a solvent or a mild abrasive cleaner before further waxing.

A relatively permanent colorless protective coating on aluminum is given by one or two coats of clear methacrylate lacquer. This lacquer coating can best be applied with a spray gun. However, formulations for brush application are also available.

The best lacquering results are obtained by first cleaning the aluminum surface (except anodized surfaces which require no preparation) with an etching-type cleaner. A solution of one part cleaner to three parts water will provide a good "tooth" on the aluminum surface for better lacquer adhesion. Apply the solution over a small area that can be kept wet for three to five minutes. Before solution dries, flush surface with clean water—paying particular attention to cracks, grooves, corners and holes. Dry thoroughly. Swabbing with a half-and-half solution of denatured or wood alcohol and water will hasten drying.

Like all exterior surfaces, aluminum will collect air-borne dust and grime. Regular periodic cleaning will help preserve the appearance of any finish.

NOTE: Upon your request for reprints of this advertisement, we will also send you a brochure containing a list of materials suitable for cleaning and protecting aluminum. (These materials have been evaluated by Kaiser Aluminum's Department of Metallurgical Research, but inclusion in the list does not constitute an endorsement or preference over similar materials intended for the same purpose.)

And for further information and assistance concerning specific problems in cleaning and protecting aluminum surfaces, contact the Kaiser Aluminum sales office or distributor listed in your telephone directory. Kaiser Aluminum & Chemical Sales, Inc., *General Sales Office*, Palmolive Bldg., Chicago 11, Ill.

see our catalog in PRODUCT DESIGN FILE or write for copy

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Reduce design and installation time

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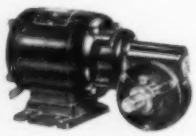
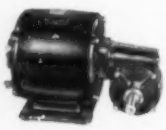
Bodine manufactures the world's most complete line of speed reducer motors in the sub-fractional horsepower range. Speeds down to 0.6 rpm. Torques up to 350 in. lbs. Here's part of the Bodine Speed Reducer Motor line:

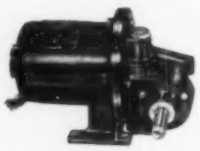
. . . single or double reduction reducer for transmitting low torques over a wide range of speeds. The worm is of long wearing nitralloy steel (except for low-powered V-10R and NSP-11R); the gear of laminated bakelite, giving quietness and durability. Motor shaft equipped with ball or sleeve bearings. Speeds from 833 to 1.5 rpm. Torques 12.8 in. oz. to 8 in. lbs.



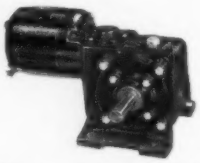
. . . single reduction, right angle worm gear reducer designed for transmitting moderate torques, Separable hardened and ground steel worm, driven by keyway on end. Laminated bakelite gear on steel hub gives maximum wear and quietness. Speeds from 500 to 29 rpm. Torques 4.5 to 21 in. lbs.



. . . sturdy, single reduction, right angle worm gear reducer, capable of transmitting substantial torques. It has a separable hardened and ground steel worm. Gears of laminated bakelite or hard gear bronze, depending on torque delivered. Grease is used with all bakelite gears; oil with bronze gears. Speeds from 500 to 29 rpm. Torques 11 to 73 in. lbs.



. . . double-worm-gear speed reducer to deliver moderate torques at low speeds. Both primary and secondary worms are of nitralloy steel. Laminated bakelite primary gear assures long wear and quietness; the hard bronze secondary gear carries substantial torque loads. Speeds from 83 to 1.6 rpm. Torques 13 to 52 in. lbs.



. . . double worm gear reducer for transmitting high torques at low speeds. Worms accurately ground from hardened steel; bakelite primary gear assures quietness; hard bronze secondary gear provides long life. Speeds from 24 to 5.7 rpm. Torques 88 to 219 in. lbs.

. . . heavy duty reducer for driving heavy loads continuously with an ample reserve for overloads. Separable steel worms are hardened and ground to size. Gear bronze, selected for strength, is cut by special hobs to close tolerances. Speeds from 173 to 36 rpm. Torques 50 to 198 in. lbs.

Write for technical bulletin 1022B. Twelve pages of facts and figures . . . 33 photos, drawings, curves, and tables tell the complete story of Bodine Worm Gear Speed Reducer Motors. For details of smaller Bodine spur-gear speed reducer motors, ask for bulletin 1023.

BODINE ELECTRIC CO., 2260 W. OHIO ST., CHICAGO 12

BODINE fractional / horsepower MOTORS

BODINE ...the power behind the leading products

...2nd of series

How to make motors last longer

Fractional horsepower electric motors, given proper maintenance, will operate without trouble for long periods of time. Here are a few maintenance suggestions:

Check internal switches. While internal switches usually give little trouble, regular attention will make them last even longer. Use fine sandpaper to clean contacts. Be sure sliding member on shaft moves freely. Check for loose screws.

Watch alignment. A motor shaft which is out of line with its load will cause the shaft and bearing to wear rapidly, sometimes damaging the driven machine.

Provide adequate wiring. Be sure that wire of proper size is used to feed electrical power to your motor. If necessary replace wire. It will prevent overheating, reduce your electric power cost, and in many instances prevent future breakdown.

Provide adequate lubrication. Remember, a motor running three times as much as usual will need three times as much attention to lubrication. Provide enough oil, but don't drown your motor. See manufacturer's recommendations.

Watch future Bodine ads for more maintenance tips.

Free chart tells how to locate motor troubles

"Common Motor Troubles and Their Causes" is the title of a 1-page bulletin and chart which will help you diagnose ailments of small motors. It lists troubles and probable causes. Copies are available on request.

PERSPECTIVES

in design and development . . .

The Patent Laws: for Whose Benefit?

On the basis of a statement by a US attorney, it would appear that the Government has come up with a strange method of reducing the backlog of patent applications in the Patent Office. The method is quite simple: discourage inventors from seeking to patent their inventions and leave them to their own devices. While this may sound somewhat facetious, a paragraph from a brief filed recently in the US Court of Appeals in New York City by the United States of America (defendant) against Dr. Otto Halpern (plaintiff) makes it quite plain that the government doesn't care whether or not an inventor takes advantage of the huge patent system specifically set up for his protection. The brief showed that the complicated patent laws make it unprofitable to do business with Uncle Sam.

Dr. Halpern's invention, because of its importance to the military effort, was covered by a secrecy order when he applied for a patent in 1944. As the application contained classified data, the patent could not be issued (be made public) although the claims were allowed. (For a full report, see PE, June 1957, p. 199). Seeking a closed court session to discuss compensation for the government's use of his invention, the plaintiff had this remark thrown at him by a government attorney:

"Most important, however, is the fact that the plaintiff was not required to submit his information to the government in connection with a patent application and thereby subject himself to the possibility of a secrecy order. He could have attempted to exploit his invention without the benefit of the patent laws. Having sought the protection of the laws of the US for his invention, he cannot now be heard to complain that he must pay a price for that protection."

To all inventors, the US is saying in effect, "I didn't ask you to come to the Patent Office, but now that you're here. . . ." The inventor is being offered three choices: (1) to take his invention—minus patent protection—to industry and run the risk of losing it completely, or coming off second best in royalty arrangements; (2) apply for patent protection and still run the risk of losing it; or (3) sell it to a foreign country, bypassing the US.

Most inventors know that if an invention could be possibly used by any branch of the military, the chances are good that the invention will have a secrecy label slapped on it by the Patent Office on recommendation of a panel of review consisting of representatives of the various military services and the Atomic Energy Commission. While the invention cannot be kept secret for more than one year, a review by the same group can renew the secrecy requirement. This can go on indefinitely.

Meanwhile, if an inventor attempts to take action against the government for holding up on a patent issue for reasons of secrecy, or tries to get compensation from the government for its use of this invention, he finds that he is tied up in legal technicalities like this one taken from the same government brief cited earlier: "Subdivision (a) of paragraph 1758 (of the US code) defines an invention as an invention or discovery covered by a patent issued by the United States. Since plaintiff concededly does not yet have a patent, he quite obviously does not come within the provisions of this statute." To make sure that this sticks, the government adds that ". . . any attempt to introduce evidence in support of this cause of action would automatically result in a forfeiture of all claims against the US arising out of his invention."

—Paul Anderson

ND FACTS

YOUR KEY TO SAVINGS IN THIS IDLER PULLEY UNIT IS

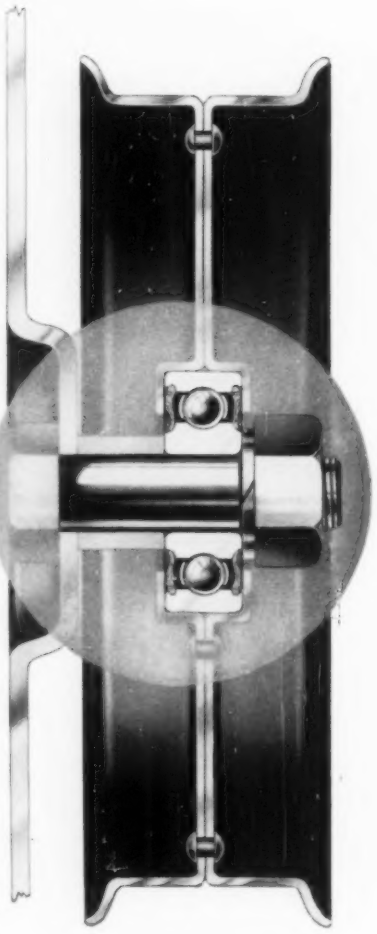
SIMPLICITY

Simplicity starts at the hub of these New Departure idler pulley units . . . with Sentri-Seal ball bearings.

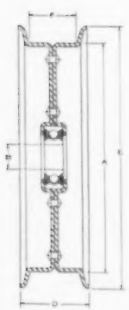
Sentri-Seal bearings are performance-proved . . . sealed and lubricated for life. *No* need for grease fittings or periodical lubricating. Economies thus gained are applied to the *sturdy construction* of the riveted pulley, where manufacturing refinements such as *rolled sheave edges* provide extra strength and prevent belt damage.

Mounting is easy, too. *Bearing bore sizes fit standard machine bolts* and since they require no maintenance attention the units can be mounted in inaccessible locations. Nothing could be *simpler—more economical.*

Write today for complete information on New Departure's two series of idler pulley units—PF Series for flat belts, PV Series for use with standard "B" Section V-belts.



Shown here is New Departure PF Series idler pulley unit for use with flat belts or backside V-belts.

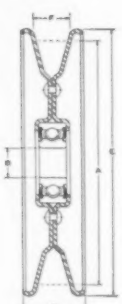


PF SERIES

PRINCIPAL DIMENSIONS

Unit No.	Eff. O.D. A	Sheave O.D. E	Sheave Width D	Mounting Bolt Diameter **B	Belt Width or Max. Groove Width F
*PF2-212	2.75	3.25	1.076	½	.700
PF2-400	4.00	4.50	1.375	½	1⅛
PF2-500	5.00	5.75	1.562	½	1⅛
PF3-600	6.00	6.75	1.590	⅝	1⅛
PV2-404	4.25	4.875	1.094	½	.737

*Idler unit PF2-212 is hardened to provide long life when used on chain drives.
**Standard machine bolt, hex head recommended.



PV SERIES

1908–1958 GM FORWARD FROM FIFTY

NEW DEPARTURE

DIVISION OF GENERAL MOTORS, BRISTOL, CONN.

NOTHING ROLLS LIKE A BALL

Product Engineering **HORIZONS**

July 7, 1958

Public Hero?

Sputnik I's beep-beep seems to have been more powerful to the man in the street than the H-bomb. At least it has had far more widespread effects. The latest is a rash of reports by sociologists, psychologists and psychiatrists on the motivations of scientists. An over-supply of data is now available for the care and feeding of the men who devise our future.

Sinister are the findings of a Purdue sociologist, for example, who studied 300 science-fiction stories of the last quarter-century, from Buck Rogers to date. He finds that scientists are more and more often the villains of the plot, and less and less frequently the heroes. They surpass business men and politicians in their unsavoriness, and all three groups far surpass the outright criminals–in science fiction, of course.

What's more, the solutions to the plot are no longer the automatic factory or the robot, as they were 46% of the time back in 1926. Now, that kind of solution is used only 26% of the time, because the problem is usually in the realm of the social sciences. The author more often relies on aliens from outer space for help. When it is considered that many authors of science fiction are said to be scientists themselves, the plot thickens.

Also, some six million Americans devour science fiction, and get much of their advanced scientific information in this way. This may indicate why, as an earlier Purdue study showed, most high-school students think scientists have a screw loose.

All in all, the publicity is helpful in establishing the importance of engineers and scientists in our modern scheme of living. Barnum once said, "There is no such thing as bad publicity." But one could wish for better publicity–even if it were just making the scientist the hero more frequently.

This matter of winning public recognition is much more involved than asking for it. Something sensational will win it faster than a sounder accomplishment that is not. Something accomplished in an area in the news at the moment will outrate by far a more solid accomplishment in an area that is obscure. This is unfortunate, but publicity and recognition are not logical phenomena. They are generated by chance, with an occasional assist by an expert. Yet they do determine reputation of individual or profession in the public eye.

Perhaps we need not fear. The public interest in engineering generated by recent events, and the obvious shift in our lives toward an engineered civilization, guarantee that the engineer and scientist will–like the meek–inherit the earth.

BELLWETHER with

Here are 26 NEW AREAS of development in fabrication, materials and processes by the aircraft industry, selected because of their probable applicability to your problems. These came from a plant-to-plant survey of this research-leading segment of Metalworking by . . .

E. J. TANGERMAN, Editor

Which recent developments in aircraft fabrication, materials and processes are likely to have the greatest impact on product design throughout industry?

This question, asked in personal visits to engineers in a dozen plants in Los Angeles, San Diego, Dallas and Fort Worth, develops an interesting picture of current engineering and manufacturing research, and forecasts some startling methods. Most deal with machining, forming and assembly, but some are concerned with materials, forging, casting and special materials.

MATERIALS

1. Steels with 280,000-psi tensile strength–AISI 4340, for instance, for parts up to 1 in. thick–are being applied for an increasing number of parts. Why? Every added pound on a bomber requires 0.8 lb more fuel; every pound on a fighter cuts ceiling a foot.

2. New materials for high strength and high temperature. Beryllium, titanium and stainless are among the special materials being studied at North American and others. Fluorine oxidizer in missile fuels forces use of high-nickel materials, for example. Lockheed is studying the high-strength steels, nickel-base alloys, titanium alloys, molybdenum (0.5% Ti), beryllium, and other refractory metals as potential high-temperature materials. One problem has been to find a material with good tear resistance, high strength at temp and at room temp after exposure, also having suitable creep characteristics. It appears from available data that fatigue, a familiar problem at normal temperatures, will not be aggravated by high temperatures.

First commercial application of 6 Al-4V titanium will be in the engine-mount area of the Convair 880 transport. Boeing has an Air Force R & D contract to develop a casting technique for titanium.

3. High-strength castings. An exceptional job is being done in both steel and aluminum castings. Possible shortages of forging capacity in the event of an emergency led to a $1-million contract for Chance Vought Aircraft and three West Coast foundries–for a 2-year program of developing high-strength steel castings. Goal is castings for tensiles from 260,000 to 300,000 psi.

Aluminum alloys are also being modified for castings to replace forgings. Commonest present casting alloy is 356, which has low ductility but generally favorable characteristics otherwise. Increase in purity of 356 gives better ductility but adds no strength–in fact, yield strength drops a little. However, higher purity permits modification of heat treat and foundry control for higher strength. Now North American has developed TENS-50, which includes beryllium to counteract iron impurity–about 0.2% to counter up to 0.4% Fe max. The beryllium may also hold magnesium in the alloy, because sprues, gates and scrap can be remelted without additions. The new alloy is stronger, has finer grain structure when cooled rapidly; may make pistons, valves and low-inertia small parts for engines and other products, but is much more costly.

4. Complex high-strength forgings. Newer planes incorporate much larger forgings of aluminum alloys, requiring little or no machining except to produce lefts and rights, for example, or for attachment points. Lockheed designs incorporating large intricate forgings on the Electra are typical of this trend. For example, the nose-wheel truss forging has ⅛-in. ribs and webs, zero draft on top and 5° draft on tension ribs. The forging, 34 x 103 in. in area, weighs 104 lb as forged, 70 lb as finished for a right or left (one of each per ship). Only ends and attachment points are machined.

A fuselage segment, also quite large, is machined all over, but the one forging makes any of four different parts depending on how it is machined. The window frame is also an integral forging incorporated in the structure. Main landing gear ribs (102 and 96 in. long) have surfaces machined to fit integral stiffeners and to make the piece right- or left-hand.

5. Plastics. Reinforced laminates fabricated from machine-coated "B"-stage resin systems are finding extensive applications up to 500 F. Typical parts: radomes, ducting, electrical isolation, nozzles, nose cones.

6. Ceramic and ceramic-coated parts. Nozzles, for example, may be ceramic or have ceramic coatings, and fighter skins may be coated to resist high temperatures. Boeing has developed ceramic coatings as a lubricant for hot forming of titanium.

7. Insulations for re-entry. Ablation or sacrificial burn-off of an insulating material is another approach to the higher-temperature re-entry problem. Nylon-phenolic looks promising.

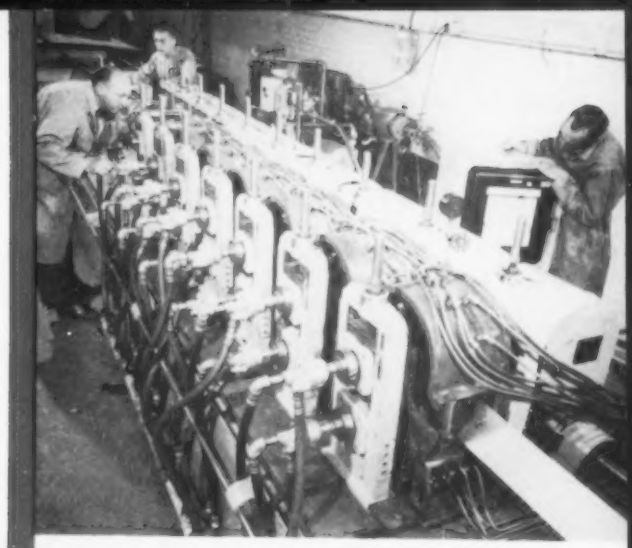
8. New fire-resistant and high-temperature hydraulic fluids promise broad application. A variety of types have

. . . TRAPPED RUBBER

WINGS

Automatic hot-squeeze riveter . . . developed for Boeing by Aircraft Tools Co. in Los Angeles, heats the rivet by current; senses when correct temperature is reached by yielding of the rivet under dwell pressure. When yielding starts, additional pressure is applied automatically to set the rivet.

HOT-FORMING TITANIUM



Complex formed shapes . . . are produced by Boeing from heated titanium strip on a Yoder mill, with furnaces enclosing each set of rolls. Strip is held at 1000 F through the process. Cold water circulates through hollow shafts to keep bearings cool. Rolling speed is about 1½ ft per min.

been developed (particularly at Douglas) for an equivalent variety of conditions.

9. Nonorganic lubricants and sealants for liquid-oxygen systems. Research has brought a better understanding of the hazards and resulted in fluids with no impact sensitivity.

10. Finishes. Many special processes for temporary and permanent finishes for abnormal conditions are in process of development or are being applied.

11. High-temperature paints and lubricants to resist jet and missile problems, but applicable elsewhere.

12. Anticorrosion finishes. Cabin pressurizing and the need for adding humidity to cabin atmosphere creates condensation problems on fuselage walls and has resulted in several new approaches.

13. Plating. Several companies are working to improve adhesion of plating to high-alloy parts, and of plastics to steel. The sensitivity of high-strength steels (260-280 ksi) to hydrogen embrittlement has increased the importance of plating without embrittlement. Many new methods are being explored, including modifications of currently used cadmium-plating baths, peen plating (Minnesota Mining), non-aqueous plating and vapor deposition (vacuum metallizing).

One new adhesion theory emphasizes the Kramer effect—the temporary radioactivity created by abrasion of steel surfaces by aluminum oxide which contains titanium as an impurity. The abraded (even slightly) surface emits measurable electrons and protons for an hour or more. If plating is undertaken within 15 minutes after abrasion, quality of the coating is improved.

14. Fuels. There are many new ideas in exotic fuels, solid fuels, thermonuclear fuels and in ion propulsion.

MACHINING

15. New machining methods. Ultrahard metals, cobalt, nickel and titanium-base alloys can be cut today, but only at the speeds of 25 years ago—60 to 100 sfpm. First predictions were that aircraft plants would have to increase their machine-tool capacity four to ten times as we shift to these materials instead of aluminum, which can be cut at today's top machine-tool speeds. To avoid it, many engineers have designed parts that require little or no machining.

Now Lockheed has suggested another way—ultra-high-speed machining. (*PE*—Mar. 31, p. 39). Preliminary studies have been made by firing a projectile (workpiece) from a rifle across a fixed toolbit at speeds up to 162,000 sfpm. At 40,000 sfpm, for example, the bit furrows the sample, like a plow going through dirt; but at 162,000 sfpm it cuts cleanly. The bit does not crumble or dull noticeably—there isn't time. Lockheed has a contract from Air Materials Command to study all known theories on high-speed cutting, including some advanced by this author in 1947 based on patents Dr. Salomon in Germany in 1932, then purchased but not exploited by Krupp.

Boeing is machining some of these alloys by routing at 4000 sfpm on old wood shapers, with solid CO_2 jetted

BELLWETHER with WINGS
CHEMICAL MILLING
Multiple-thickness semicylindrical piece, chemical-milled after forming
MANUFACTURING METHODS—RESEARCH & DEVELOPMENT
WELDING & FORMING HIGH TEMPERATURE ALLOYS
MANUFACTURING METHODS—RESEARCH & DEVELOPMENT
TRAPPED RUBBER PRECISION FORMING
MANUFACTURING METHODS—RESEARCH & DEVELOPMENT
NEW FORMING TECHNIQUES

Three demonstration panels show how Northrop is applying new forming techniques.

as the cutting fluid; several companies are using ultrasonic machining. Douglas has experimented, at least, with an ultracold cutting fluid (−40 F), may go even lower. There are also possibilities in stretch-forming at these low temperatures, particularly of materials that tend to crack at normal temperatures.

16. Chemical milling, pioneered by North American, is producing a great variety of parts economically, is also being used for analysis and test (*PE—Feb.* 3, *p.* 50). The process is doing some jobs that are otherwise impossible. One is a tapered cross-section on an H-beam for a wing spar 22 ft long. Another is etching away rib thickness in forged or cast parts that fail from stress concentrations. When the ribs are etched sufficiently, they buckle or "tin can" to show the stresses. This job is, incidentally, proof that chemical milling is the gentlest of production processes, as explosive forming is the roughest. Both are in increasing use on aircraft.

FORMING PROCESSES AND TOOLS

17. Stretch forming and other processes—hydraulic, trapped-rubber, etc. Trapped-rubber forming is doing more and more difficult jobs. Quite elaborate forms are now produced in stainless, magnesium, and other materials, with trapped-rubber acting as the female die and a built-up male (bottom) section; Masonite, plastic composition or the like are used for pressures up to 1400 psi. A Northrop addition is a swing-in set of 4200-F infrared lamps that heat the workpiece to 1600 F in less than 60 sec, then swing out to clear as the press ram descends.

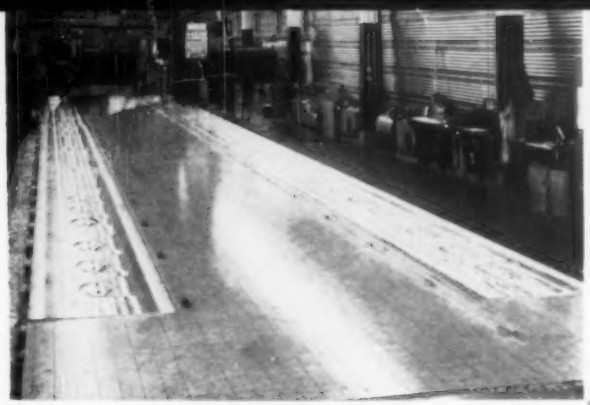
18. Epoxy fixtures, bonding fixtures, drill plates and other lightweight low-cost tooling are being produced by a variety of methods. Steel-wool fibers in the epoxy increase heat transfer as well as give strength. Drill bushings and attachment elements can be cast in place.

Metal-reinforced epoxy bonding fixtures have been highly successful in cutting costs, saving time and eliminating expensive machining. Body fixtures for honeycomb sandwich assemblies must have high thermal conductivity. Plastics do not conduct heat well enough for this application, so Northrop has tried various schemes for improving heat transfer. Steel-wool blankets reinforced with plastics for dimensional stability worked well, but total thickness was dictated by blanket depth so a base mold of aluminum was needed. Then steel wool was chopped into fibers, set in the mold and subjected to a magnetic field at right angles to the work surface. This caused fibers to form strands that stood erect and independent because of magnetic repulsion between them, like the quills on a perturbed porcupine. Then epoxy resin was poured around them. This proved to be a much better answer.

Similar techniques used in drilling and other fixtures have cut weight markedly—in one case from a ton to 58 lb.

NUMERICAL CONTROL, COMPUTERS

19. Numerical control. Extensively studied in the aircraft industry for almost 10 years, the process is now coming along so rapidly that it is expected the $100 million invested in machines can pay out in a year's time. Boeing has the largest concentration and has adapted both the IBM 704 and IBM 705 to numerical control programming. One of the latest setups is a transfer line of great versatility operating at special-machine production rates developed by Hughes Aircraft



Two sculptured wing panels . . .
for the Boeing B-52G are being produced simultaneously on tape-controlled skin mill with a table area of 12 x 80 ft. This Kearney & Trecker mill, controlled by magnetic tape, is only one of several such machines at Boeing's Seattle and Wichita plants.

working with Kearney & Trecker. (*PE*—Mar. 24, p. 28, and Mar. 31, p. 40). It is distinguished by two new characteristics:

First, the three tools in the line—they mill, drill, and bore—are horizontal single-point machines with 4-position index tables mounted on like bases. The special 20-spindle head on the drill will automatically select the desired drill, extend it and its bushing to the proper position, and then retract. Each of the two spindles on the boring tool can be adjusted automatically to the desired radius.

Second, all operations for a part are programmed on a single tape, with control signals switched to the proper machine. Thus, a change of job involves only change of tape and fixture in many cases; minor changes in machined area or position require only a change of tape.

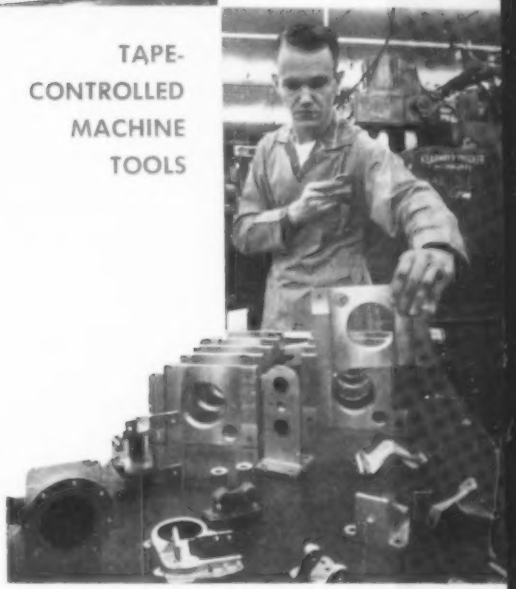
The shift to all-steel planes requires extensive numerical control to keep production rates, hence costs, in line with reality. Proper design of parts to suit production methods with numerical control is the major present need. Northrop has learned to use the relatively cheap Alwac ($60,000) computer to reproduce curves directly from the appropriate algebraic formula, rather than go through the traditional point-to-point calculations.

In design of machine tools for numerical control, one basic achievement was development of five tool motions rather than the original three, the two added ones being twist and tilt (called "twilt" in West Coast discussions). Planer-type millers with heads incorporating these added motions have been designed.

Another problem was hysteresis—weight of moving parts, friction and other elements made precise positioning of a tool difficult. In one setup at Northrop, this problem is overcome by a combination of oversize servomotors, Moog high-speed servovalves and a Bendix tape-control system on Kearney & Trecker machines.

Tape control is, incidentally, working out very well to operate Drivmatic machines for inserting fuel-proof rivets in the KC-135 tanker wing panel—the first application of nonjacketed, headless rivets. Rivets are set in a panel 20 ft long at a rate of seven per minute, about four times the hand-riveting rate. This includes drilling, countersinking, and finally shaving the rivet. Rivets are driven fuel-tight in two steps, squeezing and vibration (with underfeed followup), without O-rings, sealing or sloshing compounds. Two tapes (35-mm Mylar) do the job—one handling transverse table movement, the other the machine and longitudinal table movement.

TAPE-CONTROLLED MACHINE TOOLS



At Hughes Aircraft . . .
parts such as these are produced automatically by tape control. All operations are controlled by one tape per fixture which carries the part through each of three machine stations—milling, drilling and boring—on the new electronically controlled machine tool line below.

(Next page, please)

Conventional making of a die mold for an airfoil formerly required nine manual operations. For example, on a 2500-lb mold, a master loft board, 10 master templets and 10 PMU templets, a master model, and a plastic-faced master casting mold preceded sand casting. Total weight handled was 10,575 lb., total time 410 hr, total media cost $800. By numerical control, calculations take 40 hr instead of 20, but tape preparation is only 12 hr and machining only 24 hr, so total time is 76 hr, and media cost is $2.50. Tolerance is cut from 0.035 in. plus or minus to 0.001 in.

Next step is development of true all-purpose machine tools.

20. Computers. A great deal of work has been done toward broad use of computers for all kinds of problems including design. One of the newer things reported by Northrop is that a data-processing job which required 9 man-months was first reduced to 33 days, then to 25 days and is now 25 minutes.

ASSEMBLY PROCESSES

21. Adhesive bonding. Metal-to-metal bonding with adhesives capable of withstanding up to 500 F is now very extensively used. Dissimilar materials can be bonded quite readily. Honeycomb and similar high-strength, low-weight structures, close process control, and extensive environmental testing have brought these structures to reliable practical form. There are already indications that they may be sound answers in doors, scaffolding, truck trailers, surfboards, skiis and similar parts. Honeycomb constitutes almost the entire airfoil surface of the B-58, is responsible for its Mach 2 performance.

Bell reports that the assembled wood rotor blade for helicopters is yielding to all-metal, adhesive bonded. Such assemblies may be salvaged or corrected by cooling to −400 F, then tapping with a sledge; this breaks all bonds.

22. Welding and Brazing. Strength and heat-resistance requirements for high-speed aircraft and missiles are rising steadily, forcing extensive research in welding and brazing, particularly of the high-strength steels and titanium alloys. Solar research in this area has resulted in development of predictable production processes. Metallurgical brazing of skins to welded honeycomb sandwich is thus far the best answer, although several special structures have been developed for specific purposes.

Ryan, for example, has developed a structure of miniature-corrugated steel (17-7PH) welded to a flat-sheet skin that can stand 750 F and cut weight 25%. The assembly can be as little as 0.08 in. thick. Solar also has a corrugated sandwich; Lockheed one with a waffle-shaped core. The Lockheed structure has recently been strengthened in design by spotwelding the entire contact area of a waggle dent with the skin, thus reducing unsupported area. A weld bead laid along the exposed ridge also increases bending strength 40%.

Miniature corrugated structure . . . developed by Ryan uses sheet stock only a few thousandths thick to provide required stiffness with a substantial reduction in weight. This is Bruce Mitchell, Ryan's Chief of Structures, with some of the sheet.

Lockheed is, incidentally, a strong advocate of riveted fuselage assembly, while Boeing is going toward spotwelding. Boeing spotwelds many parts of the KC-135 tanker fuselage, as does Ryan on the fuselage sections it does on subcontract.

Rohr, in developing nacelles, landing-gear bays and doors for the Electra, did final design in only 6½ months after a compatible configuration was agreed upon. This light, fast transport will have Allison jet-prop engines, is scheduled to begin flying this fall.

Rohr and Solar are both advocates of fusion welding for heavy primary structures of modified 4340 steel. Main fuselage bulkheads and engine mounts for the B-52 are weldments, designed and built by Rohr, and have ultimate tensile strengths of 180,000 psi through the welds. Obviously, this has required much elaborate tooling—including "space-helmet" enclosed fixtures, (for Ti), special processes, new inspection techniques.

Serious load-carrying problems have been involved in the most recent turbine nacelles, according to Rohr. The J-79 turbojet, for example, is designed so that the major load must be carried in a single aft ring. Convair has been working on this problem as well, and one solution is a fusion-welded shape. On the B-58, for example, the nacelle ring, of 17-7PH stainless, was hogged out of a 1500-lb piece, although finished weight of the nonconcentric H-section U-shaped piece was only 35 lb. Convair engineers predict they can fusion-weld this assembly.

Convair-Fort Worth is also experimenting successfully with spotwelding from one side. Working with Linde, Convair has developed an argon-shielded electrode held at proper distance from the top sheet by a shielding ring. Aircraft-quality welds have been made in assemblies including four or five thicknesses of stock. The welds can be polished flush, showing only a faint ring. The welder has separate preflow, start, weld, slope, and postweld cycles. Lockheed is doing similar work.

Linde is also developing—with Convair—a small

Sonic test laboratory . . .
at Boeing measures destructive effects of high-intensity sound generated by a compressed air horn, with flow interrupted by a motor-driven chopper valve. The generator converts 4000 cfm from two 400-hp air compressors into 190-db sound. Test-cell walls are two layers of 12-in. reinforced concrete separated by dead air space; surfaces are lined with sound-absorbing material. Sound-level outside the chamber is only about 70 db.

Heliarc gun which will feed 0.020-in.-dia. wire, to obtain a smaller bead than is presently available. Convair is evaluating Linde's new small-wire MLG gun for possible airframe-fabricating applications.

Already in production use in this plant is a butt-welding technique for stainless sheet that solves the problems of obtaining brazed-honeycomb skins wider than the available 24 in. Stock 0.005 in. thick is now welded without addition of filler wire to tolerances of minus 0.001 in., plus 0.003 in., in the weld and a joint efficiency of 215,000 to 240,000 psi (against a requirement of only 180,000). Stock as thin as 0.002 in. can be butt-welded (*PE*—Apr. 21, p. 7), and joints require no finishing before assembly.

Brazed-honeycomb assembly techniques, incidentally, have been brought under control so costs are much more competitive with common techniques. Prices that range into the thousands of dollars per sq ft because of processing losses and destructive testing required are now down in the hundreds–as low as $100 per sq ft for simple sections. Delivery schedules, physicals and prices can all be guaranteed by the more-skilled fabricators, according to Solar and Rohr.

Dissimilar high-temperature alloys–often of different sheet thickness–are now being welded successfully. A pulsed welding current and plastic holding fixtures developed at Northrop will prevent 99% of the distortion from different thermal-expansion and conductivity coefficients. Strain-relieving the final assembly in matched Mechanite dies removed the rest.

23. Other assembly ideas. Several other ideas have been developed in design of the Lockheed Electra that represent latest aircraft practice. Fuselage design is framed in horizontal panels rather than in the familiar barrel-shaped segments. Four long panels go together to make a long fuselage section at assembly. Greater ease in fabricating parts and in assembly makes it possible to incorporate wiring and control ducts, piping, insulation and most of the painting beforehand. Panels are tack-riveted only in assembly fixtures, then taken to huge Drivmatic riveters which drill and countersink holes, drive rivets and machine them flush, all automatically. The riveter is tape-controlled for sequence, with the operator leveling and positioning the assembly by TV observation of the remote working center from a control pulpit.

24. Weight elimination and reduction. A great many specialized studies have been made in this area.

25. Miniaturizing. Everything from air tools to instruments has been miniaturized for aircraft use. Where weight, size or similar factors are a problem, aircraft practice is worth checking.

26. Resistance to acoustical vibration and shock. Newer jet engines and higher performance raise problems which force redesign of everything from structure to instruments. Boeing has developed accelerated sonic testing using high-intensity sirens, and has found that small free-mass dampers bonded to parts subject to damage can increase life substantially.

EDITOR'S NOTE: These articles in earlier issues this year have reported at length on specific developments coming from the aircraft field.

"Sandwich Panel Construction"; series of three articles (Jan 20, p 70; Apr 28, p 80; May 26, p 56) offer a selection guide to cores, facing materials, and adhesives—based largely on developments in the aircraft field.

"Pelletized Magnesium Extrusions," May 12, p 80, gives structural shapes with 15 to 40% increase in compressive strength, for parts calling for large sections.

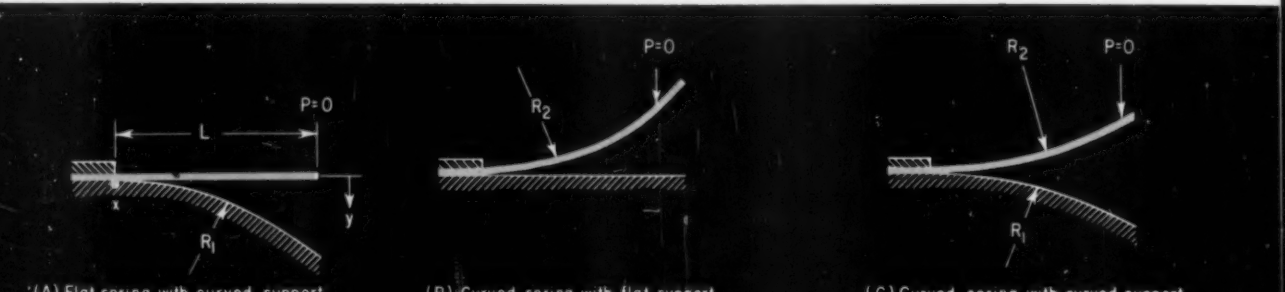
"High-integrity Aluminum Castings," Feb 17, p 69. Four steps to secure added strength and reliability for aircraft control components; how Grumman makes them work.

"Chemical Milling," Feb 3, p 50. High-speed etching gives big-scale production of parts for aircraft. First design data on parts that other shaping methods can't handle easily.

"Which Coating at High Temperature," Jan 20, p 61. Types best for corrosion resistance, erosion and compatibility with base metal for service temperatures above 1000 F. Editor's Note at end of article lists five earlier features on this topic.

"Explosives: Portable Power Packs," Jan 6, p 56. How powder-actuated energy sources are being put to work, including an explosive forming operation on compressor blades.

And many more articles appearing in 1957 and earlier—promptly reporting and interpreting developments having broad impact on design.



1. Rolling-beam cantilever springs

Providing a curved support for a cantilever protects it from overstress and triples its energy capacity. Here are design equations and details covering 7 types of . . .

CANTILEVER SPRINGS *That Roll with the Load*

JOHN D. HOWELL, *Development Engineer, Wallace & Tiernan, Inc., Belleville, N. J.*

You can have a better cantilever spring by supporting it with a curved surface. This allows the beam to bend beyond the normal safe limit and thereby overcomes the two disadvantages that otherwise limit performance of the cantilever:

1. It prevents overstress. Excessive deflection—from a sudden shock load, or overtravel of a lever—no longer can break the spring or give it a permanent set.

2. It increases energy that can safely be stored in the spring. By itself, a cantilever does not make best use of materials or available space (volume efficiency) because load stresses vary from maximum at the base to zero at the free end—all sections are not sharing the work equally.

Modifying the conventional rectangular cantilever can improve it as an energy-storing unit. For example, the triangular, trapezoidal, parabolic and tapered-beam springs which Dr. Karl Maier discussed in the Feb. 17 issue.

But a curved support under the spring, as shown above, is superior because it provides maximum volume efficiency and freedom from overstress.

Under load, for example, a flat, conventional cantilever spring assumes a parabolic shape. The radius of curvature R_1 is important. The trick is to select it so it will not interfere with spring deflection until the design stress—maximum that the material can safely take—is reached at the base, point x. Beyond this point, where further deflection would overstress, a curved support becomes valuable—the spring now begins to roll over the supporting contour. Each section successively reaches—but is prevented from exceeding—the design stress; when the spring is completely flattened along the circular curve, every portion of spring is doing its maximum amount of work. Such design requires no modification of the spring, yet permits storing three times the energy of an unsupported spring in the available space. The principle works with curved springs too, as shown in (B) and (C) of Fig. 1.

Radius of the support R_1 or the free radius of the spring R_2 can be computed from:

$$\frac{1}{R_1} + \frac{1}{R_2} = \frac{2S}{hE}$$

where h is beam thickness, E is modulus of elasticity, S is design stress.

Such a spring will give a load proportional to deflection until the design stress is reached ($y = PL^3/3EI$); then the spring begins to roll over the support, resulting in a rapidly increasing stiffness, Fig. 2, as expressed by

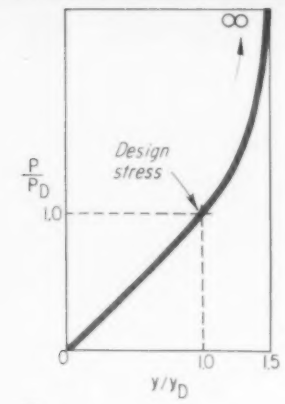
$$y = \frac{M_D^3}{6\,EI}\left(\frac{3}{P_D^2} - \frac{1}{P^2}\right)$$

where y is deflection, M_D is bending moment producing the design stress ($M_D = P_D L$), L is beam length, and subscript D denotes values at design stress.

While this equation indicates an infinite load at full deflection, it neglects deflection caused by shear strain. Allowing for this, the load at max deflection becomes $P = 0.8\ M_D/h$ (assuming G approximately two-fifths E), and the total energy stored is $U = bhLS^2/6E$.

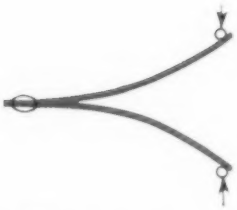
MODIFICATIONS WORK TOO

The rolling-beam principle need not be confined to simple cantilevers. Fig. 3 shows a full beam used as

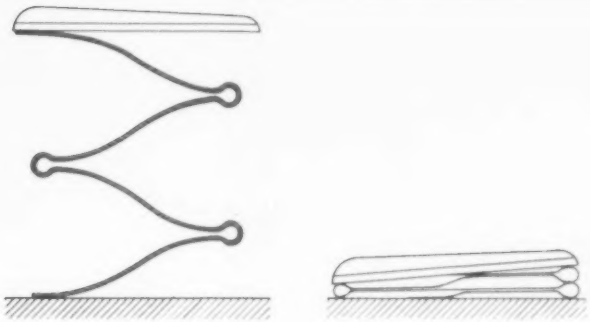


2.- Force-deflection curve

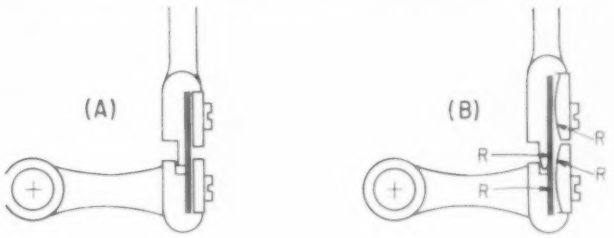
3.- Shock-absorbing spring



4.- Back-to-back spring



5.- Magazine spring



6.- Hinge springs

cushion between two flat surfaces—a simple way to get a rapidly increasing spring rate during the final stages of deflection, without possibility of overstressing.

By attaching two cantilever springs back to back, Fig. 4, each provides the stress-limiting support for the other. A similar variation is the magazine spring for rifles, Fig. 5, where the open eye closes when design stress is reached; on further deflection, the spring follows the rolling-beam principle. Here, ratio of deflection to solid height can be very high without causing buckling. Also, final deflection compresses the spring into a practically solid rectangular block, giving a high ratio of available energy. (A helical spring compressed solid is not as efficient because it remains a hollow cylinder.)

The design modification in Fig. 6 allowed the author to eliminate spring breakage in a lock stitching machine. Here, the spring acts as a hinge between an eccentric-driven connecting rod and a rocker arm. Despite small radii on the clamping surfaces of original design (A), the device had given many years of consistently good service. However, because of increased speeds demanded by the industry and difficulty at the time in obtaining high-quality steel, there was an epidemic of spring breakage. This was corrected (B) by using an arc on the clamping surfaces, with a radius large enough to protect the spring against overstress and an angle of arc equal to angle of bend of the spring.

REPRINT of this article can be obtained for your reference file by checking No. E31 on one of the Reader Service cards inside back cover. For other reprints available see "Current Reprints" listing in this issue on page 123.

EDITOR'S NOTE: When specifying stamped springs, tight tolerances can be avoided by "Functional Gaging for Flat Springs," Dec 9 '57, p 76.

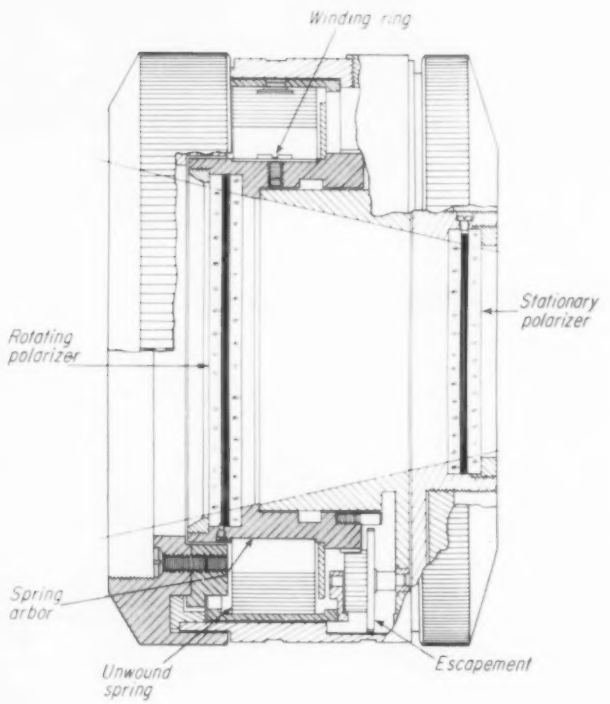
Prestessed Spring Drives Camera Aid

Device mounts on lens of a hand-held movie camera, gives professional-looking fade-out effect to picture sequence.

Prestressing, then backcoiling flat spiral spring allows storing more energy in a small space. Wollensack Optical Co., Rochester, N. Y., designed the device, made possible by a spring-winding technique developed by the Hunter Spring Co., Lansdale, Penna.

Fading action . . .

occurs when photographer presses cable release. This starts spring motor that rotates one of a pair of polarizing filters. Fadeout is complete after the front filter rotates 90°; at this point also, a two-bladed shutter closes to shut out all light. A simple escapement controls fading speed—one dissolve taking about 3½ sec. The motor drives the filter through 2½ revolutions on one winding, enough for five dissolves followed by equal number of fade-ins. An internal lock stops the action after each 90° rotation. Flag marked "open" pops out when filter grids are parallel, allowing full image.



Large-diameter arbor . . .

was needed to pass enough light through filters to camera lens. Also, outside diameter was limited to size convenient for use on hand-held camera. Spring motor had to fit annular space between 1.430-in.-OD arbor and 1.930-in.-ID restraining ring. Efficient spring motors of conventional design use flat spring stock 1/15 to 1/25 the arbor diameter—a rule that would not work here. Problem was solved by using "Spir'ator" spring designed by Hunter. Spring material is pre-stressed in manufacture, then back-wound to form working spiral. Residual stress gives high starting torque that stays nearly constant during rundown.

Giant Miller Floats in Oil

Hydrodynamic suspension accounts for smooth operation of this vertical miller that removes metal at an extremely fast rate. The high-speed tool head is guided by digital control system.

Developed for integral construction of aircraft components, the 3-dimensional miller will use a 100-hp synchronous motor, with air bearings, in its tool head. The miller, produced by The Fairey Aviation Co., Ltd., Heaton Chapel, Stockport, Eng., was designed as integral part of Ferranti control system that uses diffraction gratings as positional transducers.

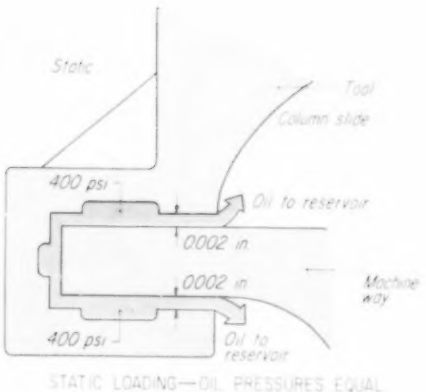
Large miller . . .

is controlled at console and does its work with high-speed head. Power for milling is supplied by synchronous motor that uses dc injection winding to reverse rotation and reduce run-down time. Oil mist is pumped through motor spindle to jets in cutter for lubrication in cutting area (interface reaches 700 C during cutting). Aluminum removal rates are 135 cu in. per min. with a 20-hp head; ultimate capacity with 100-hp head will reach 500 cu in., or 280 lb per min.

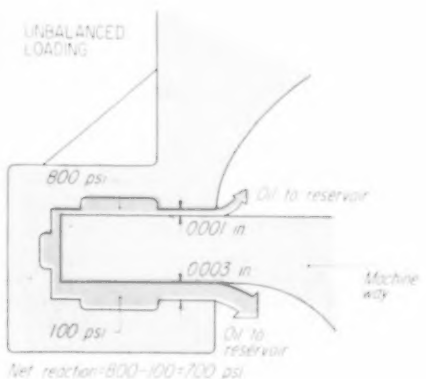
Floating tool column . . .

between "pads" (pressurized hydraulic reservoirs) eliminates stiction in slides. A 1-lb pull accelerates 9-ton column from rest to 5 in. per min. During static conditions (upper drawing), oil pumped to pads is maintained at 400 psi. Hydraulic reaction from side, top and bottom pads takes weight of column and maintains working clearance between sliding surfaces. Clearance between slide and ways acts as a linear escape orifice for oil from the pads.

Unbalanced loading (lower drawing) from the cutting reaction decreases clearance between machine way and top slide, and correspondingly increases clearance under machine way. This introduces a pressure differential between the pads, and a hydraulic reaction. Net reaction increases in direction of increased load, opposing change in static clearances. By cross-connections between pads, system compensates for tilting and skewing loads (with side pads) imposed by milling head. System has exceptional stiffness; over-all accuracy is considered to be 0.002 in.



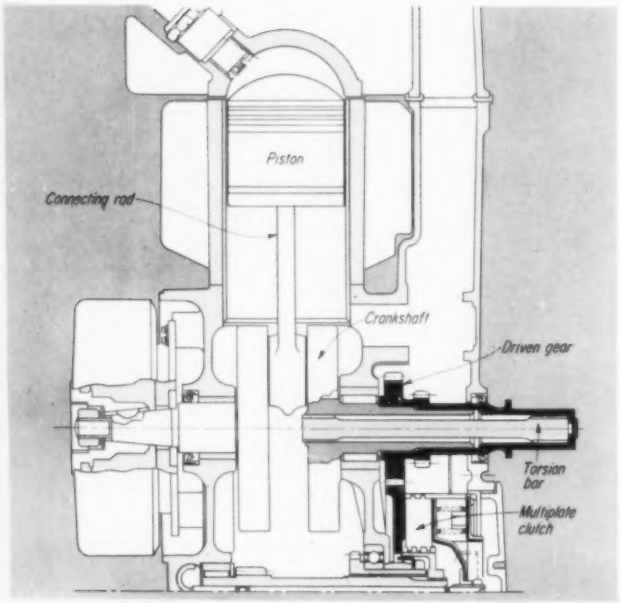
STATIC LOADING—OIL PRESSURES EQUAL



Net reaction=800−100=700 psi

Engine Tranquillized by Torsion Bars

They show in this motorcycle application how to reduce racket and rattle of high-speed single-cylinder engine—the torsion bars even out power flow in drive train and stop rocker arm in valve mechanism from bouncing off cam.



Smoother drive . . .

with this 1-cylinder engine came from introducing torsion bar between engine crankshaft and drive gearing. Torsion bar is splined to crankshaft at one end and to drive gear at other, permitting a small degree of angular displacement between the two elements. The 4-cycle engine has 98-cc displacement and 7.65-compression ratio; produces 7 hp.

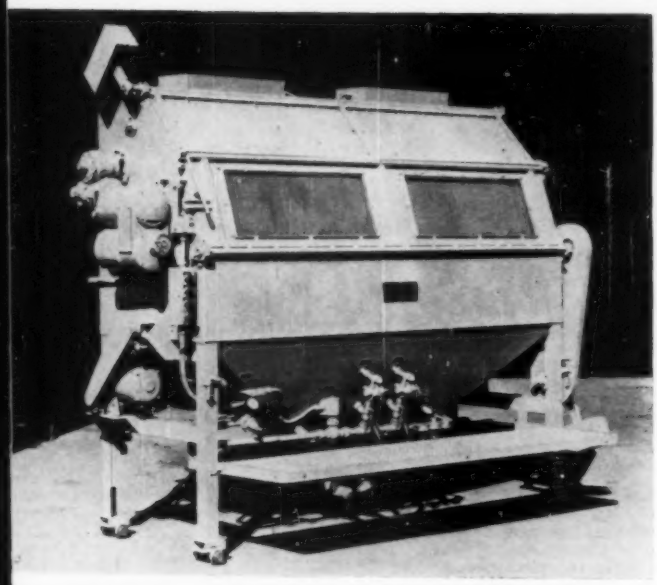
Here is an example of isolating various engine components by spring coupling—in this case, torsion bars. They were designed into motorcycles by Motom Italiana, Milan. They help reduce noise as well as cut effects of engine shock on drive gears and valve train.

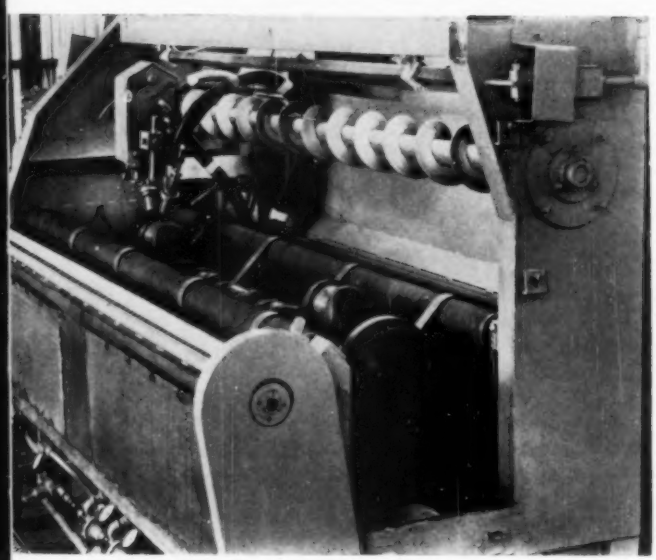
At high rpm . . .

torsion bar is answer to problem of valve rocker arms bouncing or floating rather than following cam surface. Using heavier valve springs would have caused excessive wear and raised stress in valve seats. Torsion bar connected to rocker arm keeps roller followers in positive contact with cam; and smaller valve springs can be used—torsion bar overcomes inertia of arm. Also, projecting torsion bar housings simplify cooling and allow external adjustment.

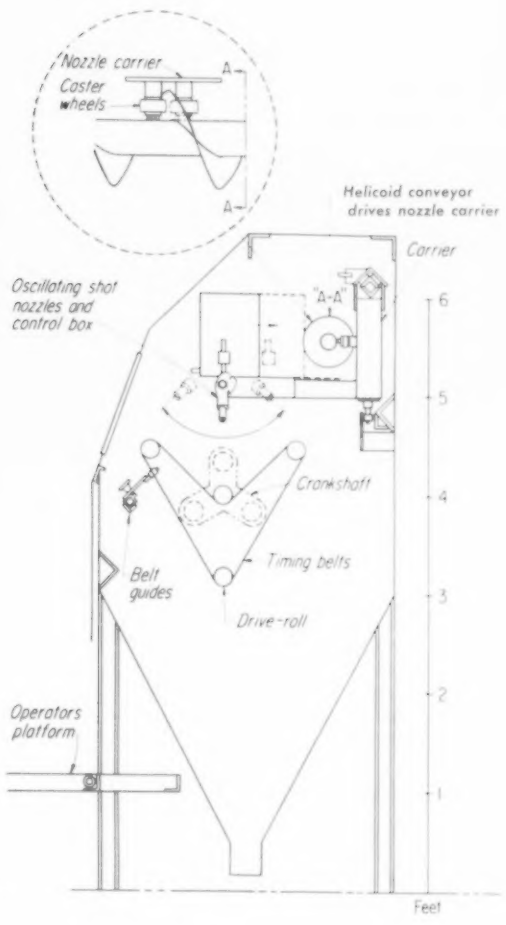
Screw Positions Nozzles for Shot Peening

Efficiency of this crankshaft-peening machine is based on automatic, precision movements. Shot is thrown by oscillating nozzles moved by helicoid conveyor while the timing belts rotate crankshaft.





"Peenamatic" handles crankshafts up to 7 ft long, was designed to provide uniform peening quality over bearing surfaces and fillets. Built-in washer blows air that removes dirt, chips and broken shot while machine operates. Manufacturer of the completely self-contained unit is Metal Improvement Equipment Co., Los Angeles.



Helicoid conveyor . . .

is shotproof and serves as lead screw that moves the shot-nozzle carrier slowly and evenly along the crankshaft. Two rubber-covered phenolic wheels act as cam followers on the screw. Variable-stroke nozzle oscillators work off rotary air cylinder controlled by pilot-operated 4-way valve. Valve poppets are depressed by shaft-mounted cams operated by an oscillating sector plate.

Timing belts . . .

have steel wire cores, are supported by three rubber covered shafts and are easily adjusted to accommodate different-type crankshafts. They need less space than spinner disks. In operation, they support as well as rotate the crankshaft.

HOW TO CALCULATE . . .

STRESSES in ADHESIVE JOINTS

Structural adhesives are getting stronger and so is the interest in this method of joining load-bearing members. The author analyzes six basic joints and shows how to calculate stress concentrations in each.

H. A. PERRY, *Consultant, Non-Metallic Materials Section, US Naval Ordnance Lab, Silver Spring, Md.*

New Book in Adhesive Field

This article was prepared from *Adhesive Bonding for Fibrous Glass Reinforced Plastics*, a book authored by Mr. Perry under the sponsorship of Owens-Corning Fiberglas Corp., and to be published by McGraw-Hill in September. A member of SPE and ASTM, Mr. Perry has been active in plastics design work for many years. His present assignments include study of fiber-reinforced laminates for mines, shell casings and missile components.

Technical coordinator on the book for Owens-Corning Fiberglas was Mr. R. H. Wagner, mechanical engineer and member of a team currently studying the elevated-temperature properties of glass-reinforced plastics for the US Air Force.

Two other recent McGraw-Hill books containing valuable information for the designer on plastics and adhesives are: *Epoxy Resins* by H. L. Lee and K. O. Neville; and *Engineering Materials Handbook* prepared by a staff of specialists and edited by Charles L. Mantell.

Rigorous analyses of stress concentrations in adhesive joints are rare. However, two types—lap and scarf joints—are elements in most of today's common joint geometries. And theory on the two types has been checked closely by laboratory tests and service experience. Result is that this theory has been extended to more complex joints. For the six most common of these, here are techniques for calculating stress concentrations.

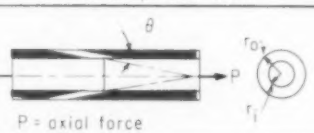
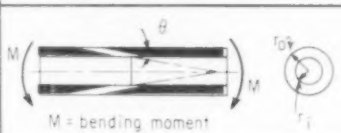
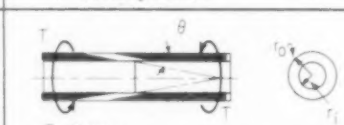
Answers given by the accompanying equations give conservative results because stress concentrations from three, often interrelated, causes must be accounted for: geometrical assymmetry in the joint, differences in elastic properties between adhesive and adherend, and property differences between adherends. This means that best use of the equations requires information in four main areas: loads and environmental conditions, failure theories for materials used, elastic and plastic properties of adhesive and adherend, and the stress levels both can take without failure. For a critical weight or cost problem, answers obtained from these equations can serve as a starting point —with the final design refined further by testing.

COLINEAR SCARF JOINT

A pure scarf joint, Fig. 1, is the most efficient of the common structural adhesive joints because it is colinear and introduces no bending. Mathematical analysis finds only an adhesive-to-air shear stress at the ends of the joint, but practice shows a modest stress concentration too. For example, tests on joints with a thickness ratio of 0.1—adhesive to adherend—reveal a shear stress factor of 1.45. For ratios under 0.1, the concentration factor is probably lower, and for ratios under 0.01 it is negligible.

The most important stresses in adhesive joints are the tensile stress at right angles to the adherend faces (tending to pull them apart), and the shear stress parallel to these faces (tending to slide them apart). In a scarf joint, the adhesive line is at an angle to the applied loads—and combined stress theory will give the modifying angle functions for calculating these key adhesive stresses. Modified equations, assuming like and isotropic adherends, are shown in Fig. 1. Adhesive stresses shown by most of these equations are all dependent upon $\sin \theta$, and can therefore be made small by choosing

1 STRESSES IN PURE SCARF JOINTS

Type	Loading	Nomenclature	Shear stress	Normal stress
Flat scarf	Tension or compression	F = force per unit width	$S_s = \frac{F}{t} \sin\theta \cos\theta$	$S_n = \frac{F}{t} \sin^2\theta$
	Pure bending	M = moment per unit width	$S_s = \frac{6M}{t} \sin\theta \cos\theta$	$S_n = \frac{6M}{t} \sin^2\theta$
Tubular scarf	Tension or compression	 P = axial force	$S_s = \frac{P}{2\pi r_0 t} \sin\theta \cos\theta$	$S = \frac{P}{2\pi r_0 t} \sin^2\theta$
	Pure bending	 M = bending moment	$S_s = \frac{2M(r_0+r_i)}{\pi(r_0^4 - r_i^4)} \sin\theta \cos\theta$	$S = \frac{2M(r_0+r_i)}{\pi(r_0^4 - r_i^4)} \sin^2\theta$
	Pure torsion	 T = torque	$S_s = \frac{2T \sin\theta}{\pi(r_0+r_i)^2}$	$S_n = 0$

a small scarf angle. This makes the joint strength dependent on adherend strength—a desirable design criterion in any adhesive joint.

BUTT JOINTS

A butt joint is a special case of the scarf joint where the scarf angle θ is 90°. Substitution of this value in the equations of Fig. 1 will give correct adhesive stresses for this configuration under various loading conditions. Under tension, a butt joint does not efficiently exploit the full strength of structural adherends because the bond area is at a minimum. As in other scarf joints, however, stress concentration is low. This means full adherend compressive strength can be developed under compressive loads. Lowest stress concentration occurs if the adhesive film is thin and rigid. Butt joints are often combined, as lands, with scarf and lap joints—a technique discussed on the next page.

SINGLE FLAT OFFSET LAP JOINT

Flat lap joints in tension are simple to make, so have undergone considerable analysis. Distortion of the joint under load is complex, Fig. 2, but the greatest stresses occur at the lap ends where both adherend and adhesive are deflected sharply as the loads shift from being eccentric to colinear. This is the same problem that occurs with riveted or welded lap joints: as the forces try to readjust, high stresses set up at the ends tend to peel the joint apart.

A useful analysis for like adherends is the Goland-Reissner theory which allows for bending and shear in the adherends. Although such analysis permits calculating stresses throughout the joint, the basic equations in Fig. 2 are for stresses at the lap ends—and give ratios of max shear and max normal stress to the average shear stress in the joint. While cumbersome, these equations can be simplified to cover the majority of cases. For example, the dimensionless factor $B = (6E_a t/Ed)^{1/4}$ is usually greater than 1.5, so $(\coth B)\ (L/2t)$ approaches $L/2t$ and the shear equation simplifies to

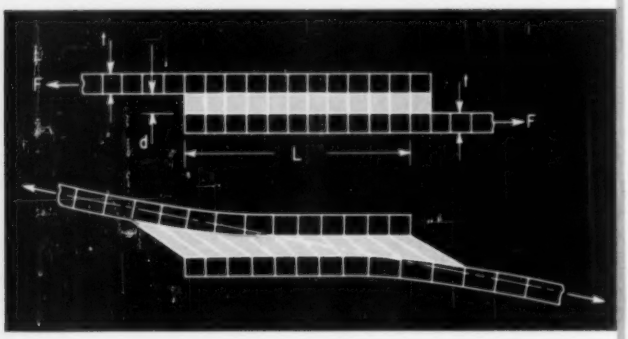
$$S_s/S_{av} = \frac{BL^2}{16\,t^2}\,(1 + 3K) + (3/4)\,(1 - K)$$

Similarly, the dimensionless factor $\lambda = (L/2t)^4 \times (6E_a t/Ed)^{1/2}$ exceeds 2.0 in most joints, so the normal stress equation reduces to

$$S_n/S_{av} = \lambda^2 K + 2\lambda K'$$

Sizing a lap joint from these equations requires trial and error calculation because the tensile stress P in the adherends appears on both sides of the equation—in S_{av}, K and K'. To size a joint of a given material (E and E_a) for a given load per unit width F, successive combinations of overlap L and adherend thickness t are selected until the stresses S_s and S_n, calculated from the equations, agree with the allowable stresses for the chosen adhesive. Moment factor K may be taken from the curve in Fig. 2. For quick, ultraconservative results,

2 SINGLE FLAT OFFSET LAP JOINT (Goland-Reissner Theory)



$$S_s/S_{av} = \frac{Bl}{8t}(1+3K)(\coth B)\frac{L}{2t} + \frac{3}{4}(1-K)$$

$$S_n/S_{av} = \lambda K \frac{\sinh 2\lambda - \sin 2\lambda}{\sinh 2\lambda + \sin 2\lambda} + 2\lambda K' \frac{\cosh 2\lambda + \cos 2\lambda}{\sinh 2\lambda + \sin 2\lambda}$$

Where

S_s = max shear stress at free ends of overlap, psi

S_n = max normal stress at free ends of overlap, psi

S_{av} = average shear stress on joint (=Pt/L=F/L), psi

F = Load in lb per in. of width, psi

P = unit stress in adherends (=F/t), psi

L = Length of overlap, in.

t = thickness of adherend, in.

d = thickness of adhesive, in.

$B = \sqrt{3E_a t/Ed}$

$\lambda = \frac{L}{2t}\sqrt[4]{\frac{6E_a t}{Ed}}$

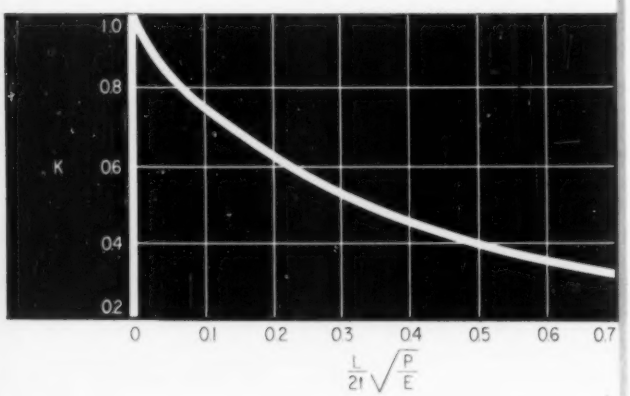
K = dimensionless moment factor (see chart below)

$K' = \frac{L}{2t}\sqrt{(1-\mu^2)P/E}$

E = elastic modulus of adherends, psi

E_a = elastic modulus of adhesive, psi

μ = Poisson's ratio of adherend



assume $K = 1$. Then

$$S_s/S_{av} = BL^2/4t^2$$

and

$$S_n/S_{av} = \lambda^2 + (\lambda L/t)\sqrt{(1-\mu^2)\,P/E}$$

Stresses obtained this way are not applicable to adherends of unlike elasticity or unequal thickness. Nor are they valid for loading other than simple tension or compression. If the adherends are very stiff or thick, the Volkerson theory for double flat lap joints, discussed next, can be applied to single flat laps where the adherends are dissimilar.

DOUBLE FLAT LAP JOINTS

Stress concentrations at the free strap ends in a double lap joint, Fig. 3, are set up because the main center member is free of strap restraint at this point—allowing it to elongate more and strain the edge of the adhesive film sharply. When strap and center member are dissimilar, differential elasticity also contributes to stress concentration here. In a properly constructed double lap, loading is symmetrical, eliminating local bending. For symmetrical loading, the straps must be equal thicknesses of like materials, but may differ from the center member in modulus and thickness. The Volkerson theory computes adhesive stresses at the free lap ends by the following equation:

$$S_s/S_{av} = \sqrt{\Delta/W} \bullet \frac{W - 1 + \cosh\sqrt{\Delta W}}{\sinh\sqrt{\Delta W}}$$

where:

$$\Delta = 3E_a L^2/8E_2 t_2 d$$

$$W = (E_1 t_1 + E_2 t_2)/E_2 t_2$$

Calculations are simplified by using the plotted form of the Volkerson equation in Fig. 3.

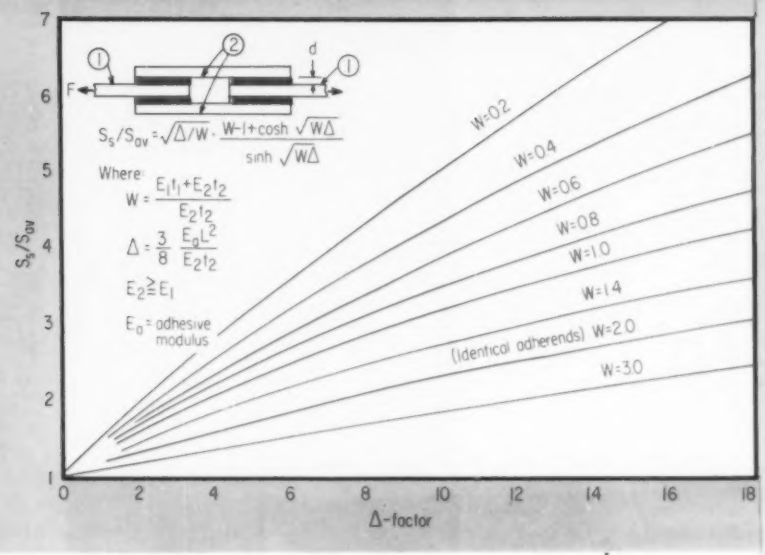
TUBULAR LAP JOINTS

Tubes in a lap joint are constrained against radial deformation, but beyond the lap there is tendency for the larger tube to neck down and the smaller tube to dilate. This local bending is taken into account, through the thickness-to-dia ratio, by an extension of Goland-Reissner equations for flat lap joints. The tubular lap equations, by Lubkin and Reissner, are cumbersome and have been translated into tabular form in Fig. 4. This table covers tubes of like thickness and material, with modulus ratio $E/G = 8/3$ and Poisson's ratio $\mu = 0.3$—these are reasonable assumptions for most common metals. If the tube walls are very thick or stiff, the Volkerson theory of Fig. 3 will give the stress concentration factor for dissimilar tubes. Here, the OD of the inner tube replaces t_1 in the W-factor calculation.

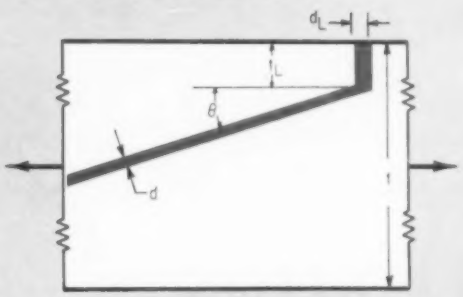
LANDED JOINTS

Lands, or stops, perform four functions in lap or scarf joints: control joint length without jigs, control adhesive thickness, avoid hard-to-maintain feathered edges, withstand large compressive forces. Lands may be bonded or left dry. If bonded, the land will help resist tensile loads, although the stress equations must be modified. If left dry, the land will take only com-

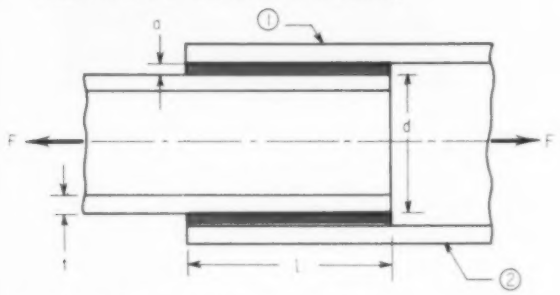
3 DOUBLE FLAT LAP JOINT (Volkersen Theory)



5 DIMENSIONS OF LANDED SCARF JOINT



4 TUBULAR LAP JOINT (Lubkin-Reissner Theory)



Nomenclature and conditions

t = tube thickness ($t_1 = t_2$)
E = elastic modulus of tube ($E_1 = E_2$)
G = shear modulus of tube ($G = \frac{3}{8}E$)
E_a = adhesive elastic modulus
l = length of overlap
d = diameter of inner tube
μ = Poisson's ratio (=0.3)
$N = S_n/S_{av}$
$T = S_s/S_{av}$

		l/d							
		01		005		0025		0010	
$\frac{qE}{tE_a}$	l/t	N	T	N	T	N	T	N	T
4	1	1.22	1.06	1.20	1.05	1.17	1.05	1.15	1.05
	2	1.52	1.18	1.56	1.20	1.57	1.21	1.57	1.21
	5	1.95	1.47	2.24	1.59	2.58	1.76	2.98	1.97
	10	2.97	2.17	2.85	2.12	3.12	2.56	3.89	2.68
20	1	1.11	1.02	1.11	1.02	1.10	1.01	1.07	1.01
	2	1.19	1.04	1.21	1.05	1.21	1.05	1.19	1.05
	5	1.37	1.13	1.52	1.18	1.68	1.24	1.87	1.32
	10	1.68	1.37	1.72	1.36	1.86	1.42	2.23	1.60
100	1	1.04	1.01	1.06	1.01	1.06	1.01	1.05	1.01
	2	1.06	1.01	1.08	1.01	1.09	1.01	1.08	1.01
	5	1.10	1.02	1.16	1.03	1.23	1.05	1.28	1.06
	10	1.18	1.08	1.23	1.08	1.31	1.10	1.40	1.15

pressive loads and the standard equations for lap or scarf joints apply.

Exact analysis of stresses in a bonded land has not yet been made. An approximate solution by Lubkin for normal stresses in the land, Fig. 5, in terms of the normal and shear stresses in the scarf portion is, for like adherends,

$$S_L = -\frac{d}{d_L}\left(S_n \sin\theta - S_s \frac{E_a}{G_a}\cos\theta\right)$$

where G_a = shear modulus of adhesive, psi

If the scarf stresses S_n and S_s are approximated by assuming the entire tensile force F is taken by the scarf length $(t - 2t_L)/\sin\theta$, the land stress S_L becomes

$$S_L = \frac{F}{t} \bullet \frac{d}{d_L}\left(1 - \frac{2t_L}{t}\right)^{-1}\left(\sin^2\theta - \frac{E_a}{G_a}\sin\theta\cos^2\theta\right)$$

Pressing the lands tightly together during bonding reduces land adhesive thickness compared with scarf adhesive thickness, so that land stresses rise sharply. Cracks may develop under low load and propagate throughout the joint. To minimize these stresses, the lands should not be pressed tightly together; or a rubber adhesive prime coat should be applied to the lands before a tightly pressed joint is made with a more rigid adhesive. Regardless of technique, land stress S_L should not exceed adhesive strength. When length tolerances are critical, however, dry lands are preferable.

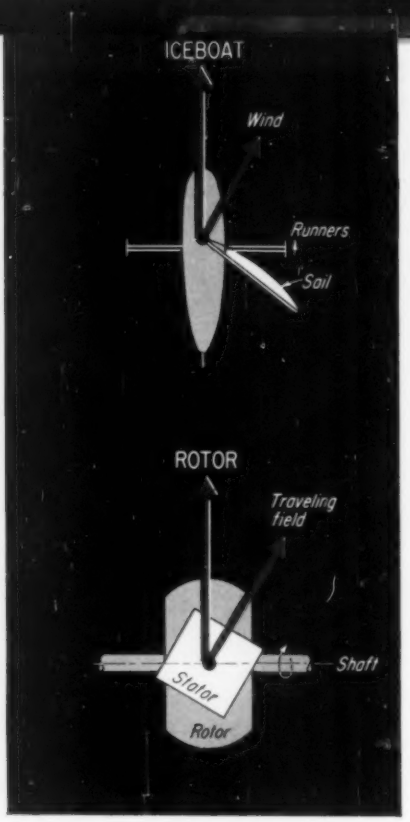
REPRINT of this article can be obtained for your reference file by checking No. E32 on one of the Reader Service cards bound in this issue. For other reprints available see "Current Reprints" listing in this issue on page 123

EDITOR'S NOTE: Recent articles on designing adhesive joints and selecting the right adhesive include the following:

"Selection Guide for Sandwich Panel Adhesives," May 26 '58, p 165, describes and compares 14 widely used cements.

"Which Adhesive for What?", Mar 17 '58, p 79, tells what a good structural adhesive must do, compares basic types in chart form, and gives a simplified shopping list.

Velocity vectors show similar effect when "tacking" with iceboat—and with stator of . . .



Britain's New VARIABLE-SPEED MOTOR

This spherical induction motor works on constant-frequency ac and does away with need for sliprings and commutators. Turning a handle changes angle of its stator and automatically speeds up the rotor.

JOHN TUNSTALL, McGraw-Hill World News, London

Comparing motors to iceboats is certainly unusual, but this spherical induction motor actually "tacks" in a magnetic field. That is, when the magnetic field is made to move at an angle instead of peripherally across the rotor surface, the rotor speeds up like an iceboat sailing at an angle to the wind.

This contrasts with the usual type of variable-speed induction motor—which depends on a frequency changer or some other external circuit to slow down or speed up the rotor.

The trick with the new motor, a squirrel-cage type, lies in the adjustable stator-block angle. In the unskewed (normal) position, it operates like an NEMA standard squirrel-cage induction motor. Electrically it is the same, because rotor currents are induced by the stator field, and the rotor tends to turn at synchronous speed, less normal slip.

Skewing the stator causes the magnetic field to travel at an angle to the rotor. The rotor, which has a matrix (mesh) of conductors approximating a conducting surface, experiences induced currents at right angles to direction of movement of the magnetic field. The rotor then tries to follow the field, but cannot because the shaft and bearings restrict it to straight rotation. The effort to "keep up" results in greater linear movement for a point on the rotor than for the field front. Like the iceboat, the rotor now goes faster than its propelling medium. Increasing the angle increases speed.

Predicted Performance

Efficiencies and power factors of these skewed-stator motors are comparable with fixed-speed induction motors of the same size and number of poles.

Commercial lines are not presently available, but many development models and prototypes have been built and tested. All spherical rotors have been 14 in. dia., the max capacity of workshop lathes. Rotor length is kept significantly smaller than dia to limit peripheral speed changes caused by spherical shape. The first machine (in 1954) developed 2 hp with a single stator pad. Later prototypes had 14-hp output, 0.7 power factor, 5.5-to-1 speed range, and about 70% efficiency over most of speed range. Efficiency tends to increase with number of poles and to decrease with pole pitch. Therefore larger motors, above 50 hp, are best because more poles can be fitted in.

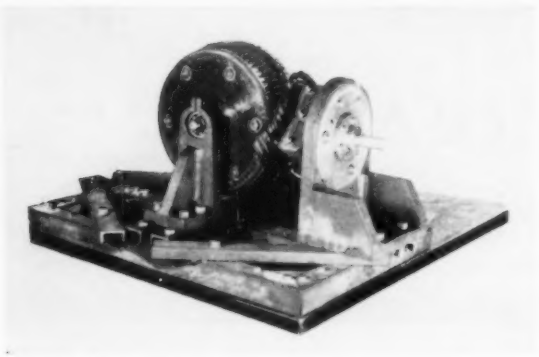
Metropolitan-Vickers is building a 200-hp spherical motor. Bruce Peebles, Ltd., has begun design of a 500-hp spherical motor for the purpose of assessing suitability of an 8000-hp version for gas blowers in nuclear power stations.

Design and Cost

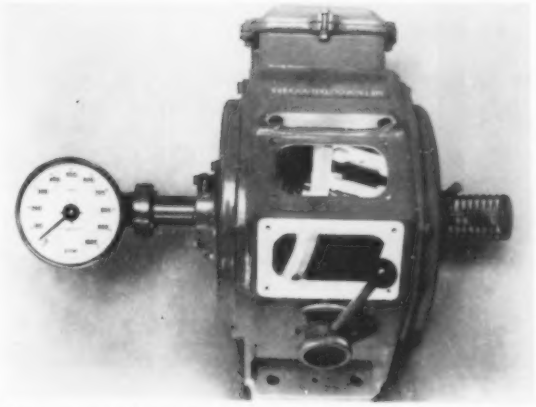
It is believed that specific weight and cost can be lower than for any existing variable-speed machine. Reasons are simple construction and elimination of external circuitry. Brushes, stepped-resistance banks, and electronic controls are not needed. Rather, a simple handle on the motor is turned to the desired speed setting.

The rotor must be spherically shaped to allow rotation of the stator block on its axis perpendicular to the shaft. The rotor is assembled from circular disks in stepped sizes to approximate a sphere. Slots in the disks, and smaller-dia spacers between, form a matrix into which conducting material is cast. Machining is

WHAT THIS VARIABLE-SPEED MOTOR LOOKS LIKE



Rotatable stator . . .
on development version gives speed adjustment merely by turning a handle. Other external controls, or variable frequency, are not needed.



Commercial prototype . . .
also shows handle that skews stator. This model, built with cooperation of Manchester University staff that developed motor, is 1 hp; same company is building a 200-hp version.

necessary to form a smooth spherical surface on the disk edges.

Spherical stator blocks are assembled from identically-punched axial laminations, and require no further machining. Slots are pre-skewed so that a high-speed condition occurs with the stator block itself unskewed. This makes fullest use of the stator pole face area, at least for the speed setting selected.

EDITOR'S NOTE: Many methods of ac-motor speed control, some widely used, others for special applications, have appeared in these pages previously.

Control in "steps" of speed is possible with ac motors that have multiple windings. See: "Controls for Multispeed Motors," Feb '57, p 183, which explains available winding arrangements; and "Multispeed Motors," June 57, p 140, for performance characteristics such as starting and running torque.

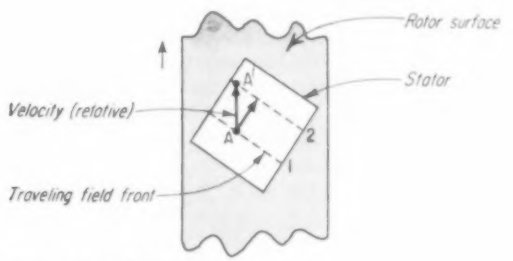
Other adjustable-speed drives are discussed in: "Ac Motor Has Integral Stepless Control," Aug 55, p 210, which shows how "Schrage" principle (2 windings on rotor—one is commutated and opposes other) simplifies speed control; "Variable-speed Ac Motor," Sept '55, p 215, which depicts how an induction regulator serves to oppose rotor emf and therefore change synchronous speed; "Adjustable Frequency Multimotor Drives," May '52, p 146, which describes motor-generator approach to vary speed of reluctance, squirrel cage, and wound-rotor motor; and "Control Motors by Varying Frequency," Dec 23 '57, p 102, which features variable-speed gearbox for ac generator.

Fractional-hp motor control is the topic in: "Adjustable Electronic Drive for Fractional-hp Motor," Jan '57, p 222. It shows how thyratrons and silicon rectifiers are helpful in speed control.

A summation of existing electrically controlled speed changers is found in "How Adjustable-speed Electronic Drives Compare," Nov '52, p 189.

Dc motor control receives thorough treatment in the following articles: "Improved Dc Motors," Mar 31 '58, p 108, discusses static field and armature control; "Drive and Control Package," June '55, p 214, describes typical Ward-Leonard System; and "Forced-torque Electric Adjustable-speed Drives," Apr '54, p 168, shows how 8 times' normal voltage, applied momentarily to dc motor in Ward-Leonard system, will accelerate it rapidly to any speed without damage.

Most spherical motors . . .
are now built with skewed slots in stator blocks. This is better than having slots parallel to block sides, because block is square (and covers full active area) at a higher speed position.



Traveling field front . . .
in ac stator pole windings moves from positions (1) to (2) in same interval of time that point A on rotor moves to A'. This is because induced currents in conducting matrix of rotor surface align themselves parallel to wave front at (1) and remain in step.

GLASS and CERAMIC FIBERS—they beat the heat

Modern technology is turning sand and clay into an ever-increasing variety of thread-like materials with rugged properties. Design data given here, on three of the most important types, is taken from the forthcoming Academic Press book, *Modern Materials*, edited by H. H. Hausner.

T. D. CALLINAN
International Business Machines Corp.
Poughkeepsie, N. Y.

When design calls for a fabric or fiber with special properties, look into the advantages of glass, silica or ceramics. They are winning new respect nowadays. Along with electrical and thermal insulation, plus added strength, they give resistance to heat, fire and corrosion.

Furthermore, they are now available in many forms. In addition to cloth, tape, rope and mesh, all three materials can be made into paper, felt and rigid sheet or board, with possible applications ranging from engine mufflers to printed circuits. Here is how they are made, what they offer, and where they may be used.

GLASS FIBERS

The term "glass fibers" serves to distinguish glassy, inorganic filaments from ceramic filaments (where the inorganic composition may consist of discrete, sintered crystals), and from totally crystalline inorganic fibers, such as those of the minerals chrysotile, crocidolite, tremolite, and anthophylite.

There is an unlimited amount of sand from which glass fibers can be spun, and no enormous chemical industry is required to prepare the basic ingredients. Moreover, these fibers are nonflammable and mechanically strong under specific conditions.

Properties are dependent on the composition, furnace temperature, and rate at which the fibers are drawn. By varying composition and drawing rate it is possible to produce fibers in continuous lengths as fine as 5 microns (0.0002 in.), and coarse as horse hair (40 microns). Finer fibers have been prepared, but only in staple lengths.

What's available

Commercially available are a host of cloths, tapes, and yarns made from continuous filaments of glass. They are finding widespread use where thermal stability, electrical resistivity, and resistance to moisture are significant requirements. The materials are mechanically strong, and have been successfully used as wrappings for armatures and field coils in electric motors and generators, as turn insulation in transformers, as pipe protection, and stripping tapes.

Better materials coming up

Present research in continuous-filament glass-fiber products is directed at the major limitation of present materials: If a glass fiber is scratched, it breaks. As a temporary expedient, organic oils and sizes are used as "lubricants," but this introduces an organic contaminant to an otherwise wholly inorganic material. Changes in chemical composition are being investigated to obtain fibers with self-lubricating surfaces.

Glass fibers offer wide variety in composition. For example, they can be made highly reactive chemically—or highly inert. The range also includes electrically conducting fibers, as well as those with a high dielectric constant; fibers chemically uniform in cross-section; also those in which the chemical structure of the outer casing differs appreciably from that of the inner core.

Special fibers for special jobs

"Tailor-made" glass fibers have been prepared to solve problems in many fields. When the glass contains neither boron nor cadmium, it gives fibers for thermal insulation and for filtration units in regions of high neutron flux near nuclear reactors.

SILICA FIBERS

Although glass fibers have greater thermal stability than organic fibers, they are unsuitable for certain

high-temperature uses. Where temperatures may be greater than 1100 F, fibers must be high in silica or alumina, and free from such fluxes as sodium and boric oxides. Furthermore, the electrical losses of lime-borosilicate glasses increase significantly at high frequencies, preventing their use in many radio applications. Such compositions are also attacked and pitted by water. Again, many applications of nuclear power require the absence of elements having high neutron-capture values, thus precluding the use of boron. For these and other reasons, there is much current interest in fibers made almost entirely of silica.

It is, of course, possible to make quartz fibers by drawing them from a quartz rod, but it is a modification of the method of making fused silica bodies that is employed commercially. An alkali-borosilicate glass is melted and shaped, the part is heat-treated, and the glass changes into two intermingled glassy phases: one high in alkali and soluble in hot mineral acids; the other containing 96% silica, and insoluble. The heat-treated part is immersed in hot acid, the soluble phase is leached out, and the high-silica phase remains. It is porous.

Glass that shrinks

The ultrafine pores average about 40 angstroms in diameter, and the pore volume about 35%. This porous glass is then heated to 2300 F. The glass shrinks 14%, and the porous structure becomes consolidated. Fibers which have been leached but not heat-treated are available, as well as those which have been annealed at 1200 F. Cordage, sleeving, and cloth from this material are available commercially.

In bulk, the fibers have found use as thermal insulation because the materials have low thermal conductivity, even at high temperatures. Thus silica fiber, having a density of 3 lb/cu ft has a thermal conductivity of 2.4 at 1600 F; and when compressed to 9 lb/cu ft has a value of 1.35.

The individual fibers are white in color and resemble cotton. Woven products are similar in appearance to glass textiles. The fibers are available in diameters of 0.000020 to 0.00040 in. They withstand continuous operating temperatures up to 1800 F. The chemical properties are similar to those of vitreous silica. The fibers are marketed in bulk form as cut staple having a density of 2 lb/cu ft, or in cut tow that is 18 in. long with a density of 4 lb/cu ft.

CERAMIC FIBERS

Mineral wools prepared from slags are usually thought of as being dirty, dusty, fibrous mats, useful only for such mundane applications as house insulation. The fibers are coarse, fragile, and varying in diameter, but they are widely used because the process by which they are made is fast and inexpensive. A low-melting slag is heated in a gas-fired furnace, and the molten mass is allowed to fall into a jet of steam, which forms the fibers.

Differing markedly from this conventional mineral wool is a ceramic fiber that starts with a mixture of alumina and silica (mullite), with a small amount of zircon and boron oxide. It is melted in an electric furnace and poured out in a stream into a steam jet. In a manner similar to that employed in the staple glass-fiber field, the particles of molten mullite are attenuated and fiberized, then they are collected in bulk form.

For higher heat

This fiber is available commercially as a competitor to staple glass fiber for spinning, weaving, and paper-making applications. Since it possesses greater thermal stability than glass, it has advantages as thermal insulation. The fiber is a white, cotton-like mass. It is made up of random arrangements of extremely fine fibers up to 3 in. long and having an average dia of 4 microns—with an actual range from 10 microns down to less than 1 micron. The product has a density of 2 lb/cu ft. The mat can be readily compressed; a pressure of 2 psi compresses it to a density of 12 lb/cu ft. Mats are available in a number of forms for thermal insulants, filters, or electrical insulating papers.

The fibers are thermally stable in the presence of oxygen, even at temperatures above 2700 F. In the presence of hydrogen, there is no reduction to aluminum. In the presence of mineral acids, the fiber is attacked and alumina is leached out of the matrix. The residual silica remains in a fibrous gel form. The material does not melt or sinter at elevated temperatures but there is a gradual change from an amorphous glassy structure to a crystalline structure at exposures above 2000 F, the change proceeding faster at higher temperatures.

Other advantages for design

These fibers are highly resilient, have good abrasion resistance, do not shatter under conditions of vibration, and have lower packing densities than less resilient fibrous materials. They therefore serve as packings in expansion joints and for roll insulation. They have been used successfully as sound absorbers in mufflers and rocket-engine test stands, and also to filter hot gases at temperatures too high for glass, mineral, or metal fibers.

Blankets manufactured from short-staple ceramic fibers provide convenient, economical, and highly effective insulation for temperatures up to at least 2300 F. Such blankets have a density of approximately 6 lb/cu ft, and are available in rolls ½ in. thick and 25 ft long. The "K" factors are good, being 0.5 to 600 F, 1.45 at 1400 F, and 2.26 at 2000 F.

Papers, boards, blankets

Ceramic fiber paper is available in sheet and roll form in thicknesses of 0.020, 0.040, and 0.080 in.

Applications include gaskets for hot gas ducts; cushioning materials between metals and brittle ceramics; low heat-capacity, refractory facings on steel and other metals; protective sheet to prevent scratching of polished

metal during heat treatment; and inorganic or organic bonded laminates.

Rigid sheet or board made of ceramic fiber is available in experimental quantities, and usable at high temperatures. The present dimensions in flat sheet are 12 in. wide and 36 in. long. Thickness ranges from $\frac{1}{8}$ to $\frac{3}{8}$ in. Development work is under way to form the product into shapes such as tubing 2 to 6 in. in dia, half-cylinders, corrugated sheets, and other simple forms.

Ceramic fiber roving is made from a blend of long-staple ceramic fibers and organic carrier fiber, condensed to a single strand without twist. It is capable of continuous service at temperatures above 2000 F and although it loses the organic carrier fibers at elevated temperatures, it retains its form and insulating quality. The characteristics of this product suggest its use as insulation for heater cords, cables, electrical heating elements, and other applications where a bulky, resilient, high-temperature wrapping or core material is required.

Ceramic fiber rope is produced in the twisted three-strand type, in a range of $\frac{3}{8}$ to $\frac{3}{4}$ in. dia. It is made from a carded blend, a long-staple ceramic fiber, and an organic carrier fiber. Three strands of "wicking" are twisted together to obtain the finished product. Where high strength is required at elevated temperatures, a special rope can be made in which alloy wire in inserted. Its resiliency and resistance to heat suggest its use for thermal insulation, expansion joint packings, seals, gaskets, and cores for braided products. It is available in densities of 16 to 56 lb./cu ft.

After 24-hr exposure at 1800 F the material still has a breaking strength of 10 lb compared with an initial strength of 80 lb.

Cloth for hot spots

Woven cloth is made from ceramic fiber in a variety of widths, weights, weaves, and thicknesses. These include tapes, broadwoven goods, and seamless tubes. The material, 80-85% ceramic fiber and 15-20% organic carrier, is commercially available in plain or twill weave.

Ceramic cloth retains its form at temperatures above 2000 F, but tensile strength is not substantial at high temperatures, unless such material as alloy wire is inserted. Ceramic cloth inserted with stainless-steel wire retains approximately 50% of its original strength after exposure at 1500 F in an oven for 24 hours; inserted with nickel-chrome alloy wire, it retains about 50% of its original strength after 24 hours at 2000 F. The cloth is not resistant to direct mechanical abrasion after exposure to these temperatures.

EDITOR'S NOTE: For information on fiber materials, see "Fiber-base Structural Materials," Feb. '57, p. 164; and "Synthetic Fiber Felt," July '57, p. 178. A new idea in fiber application is described in "Now—Sprayed Reinforced Plastics," Jan. 13, '58, p. 17.

HOW MOSCOW DESIGNS
coming July 14

Your next R & D News Edition will be devoted to one subject only—design engineering in the Soviet Union. Our chief editor spent two weeks in and around Moscow, visiting the largest design institute and the largest auto plant, previewing the huge Industrial Exhibition, checking the Polytechnical Museum and the stores, interviewing members of the Academy of Sciences, engineers, editors, officials. From these varied sources, he has assembled a detailed technical report on how USSR research, development and design are done. We give it to you in one compact, easy-reading package on July 14.

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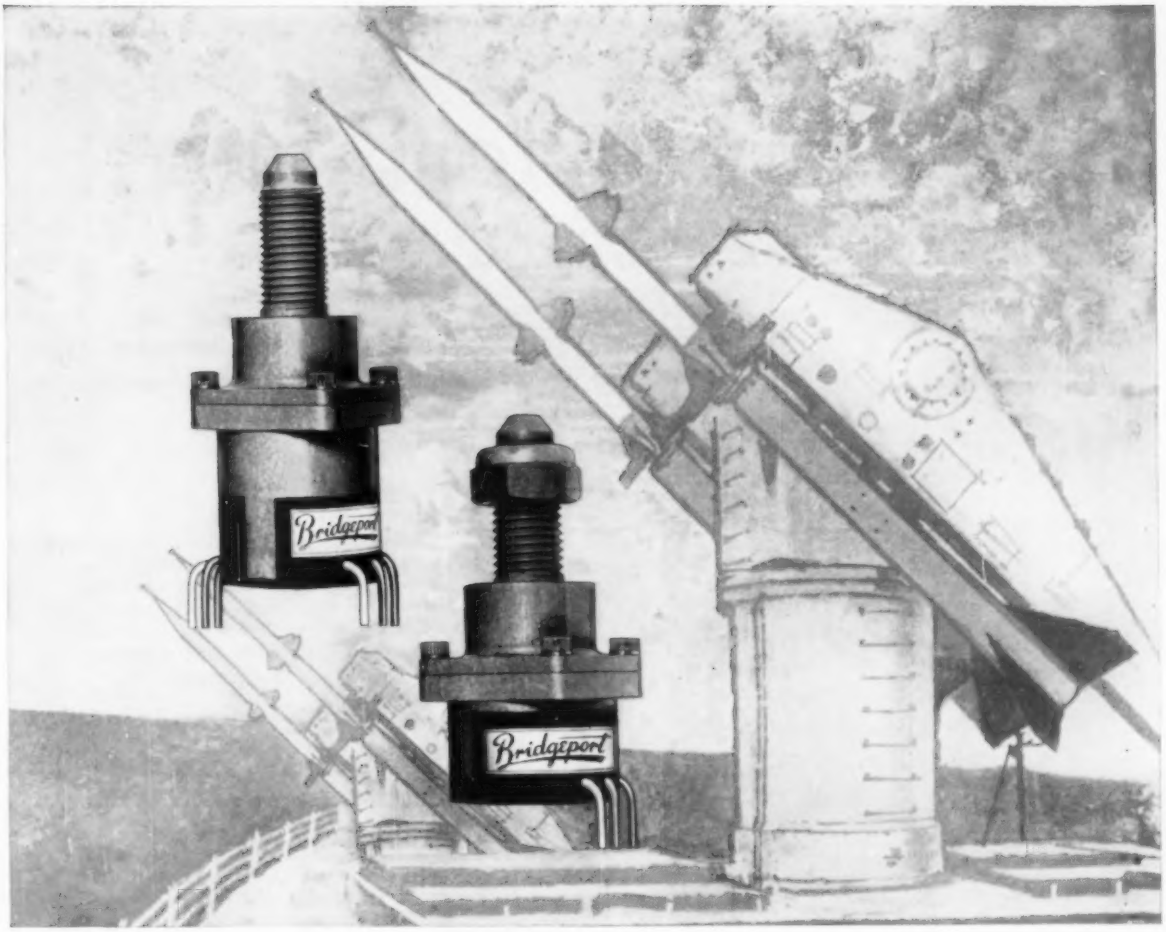

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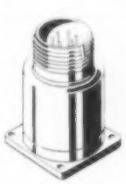
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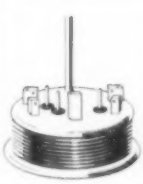
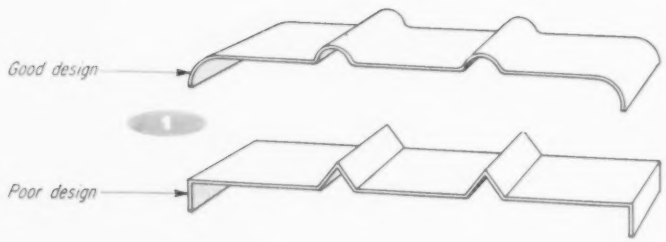

FORMSET BELLOWS

PACKAGED BELLOWS

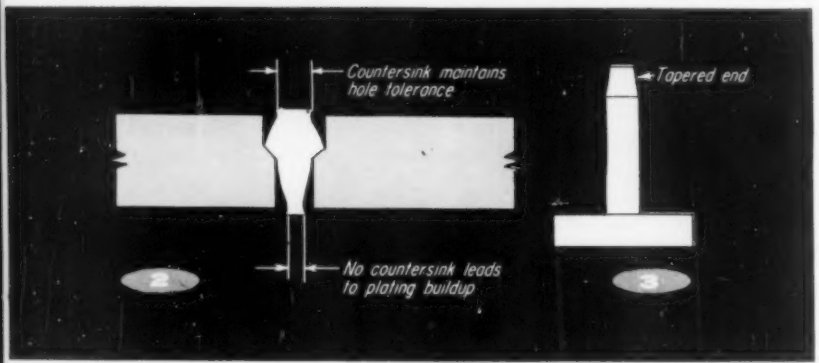
For BETTER ELECTROPLATING . . .

PETER C. NOY, Manufacturing Engineer, Canadian General Electric Co., Ltd., Barrie, Ont.

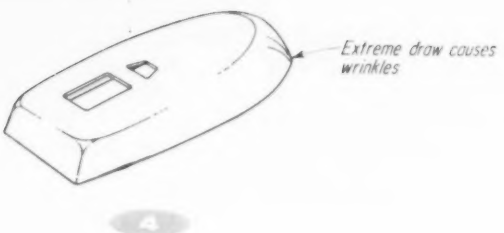
Nine other electroplating hints—dealing with better mounting, drainage, radii—were given in the June 23 issue, page 94.



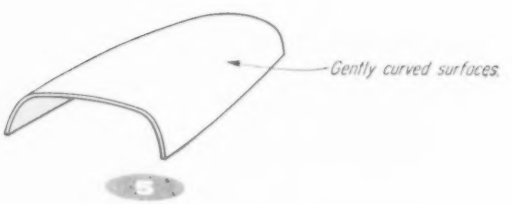
Ridges and grooves . . . on brightly finished presswork should be rounded as much as possible. The plating buildup that occurs on sharp ridges is not only wasteful, but—when abnormally thick—causes greater stress and often increases brittleness. Combined with buffing-wheel pressure in later operations, this condition can weaken the plate.



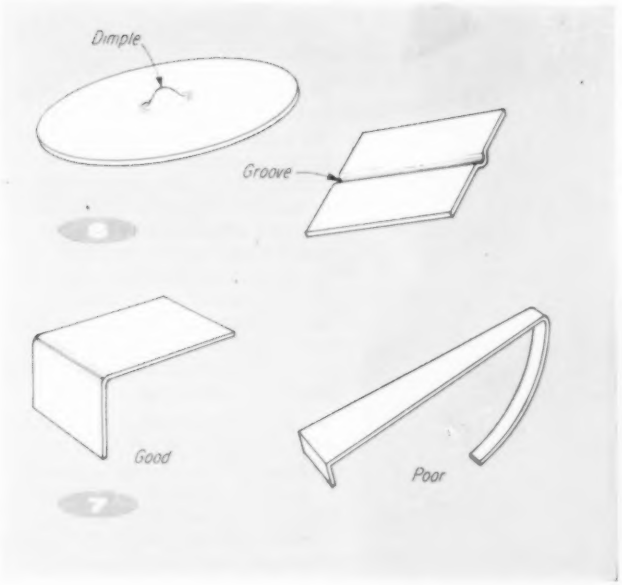
Adequate hole tolerance . . . is necessary to prevent the buildup on hole edges that reduces effective dia. Countersink (2) to keep hole fully open—deep in the hole, plating will be deposited either very thinly or not at all. Studs (3) should, for similar reasons, be provided with tapered entry; otherwise, excessive tolerances may be necessary.



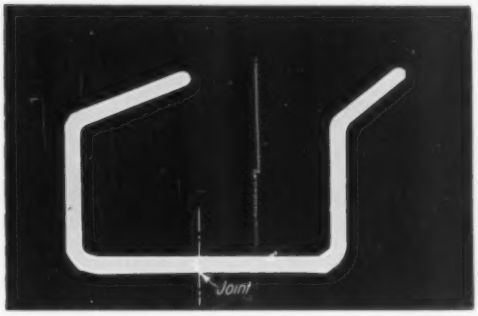
Draws on presswork . . . should be as gentle as possible. Extreme draws (4) often cause wrinkles. When these are polished out, the crystalline center of the metal, instead of the wrought surface, is bared to the plating solution. Gently curved surfaces on highly finished presswork (5) are easier to buff and polish than flat surfaces.



. . . These answers to trouble spots



Small flat parts . . .
that will be barrel plated should be grooved or dimpled (6). This prevents them from clinging together and blanking one another from the plating solution. Small parts (7) should also be stable enough to withstand the vigorous tumbling action of barrel plating without distorting permanently or becoming badly entangled.

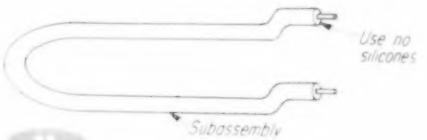


8

Extra large parts . . .
such as metal furniture and other tubular units should be designed in sections convenient to plate. Few plating solutions are more than 3 ft, 6 in. deep.

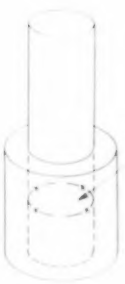
GENERAL HINTS

Pure tin solder (9) should be specified on all assemblies. Lead is hard to prepare for plating, contaminates adjacent metals and causes plate failure from lack of adhesion.



Compatibility with plating solution (11) is essential for materials used on plated subassemblies. Silicones, for example, will kill all foams purposely produced in cleaning and plating solutions; rubber gaskets will dissolve or thicken; aluminum dissolves.

For deeply recessed parts (10) chrome plate will not "throw" in recesses unless auxiliary anodes are used. Nickel is better but real corrosion resistance may require special processes or designs.



Silver-brazed joints . . .
on decorative copper alloy work should be hidden from sight—the silver alloys will result in a matte finish.

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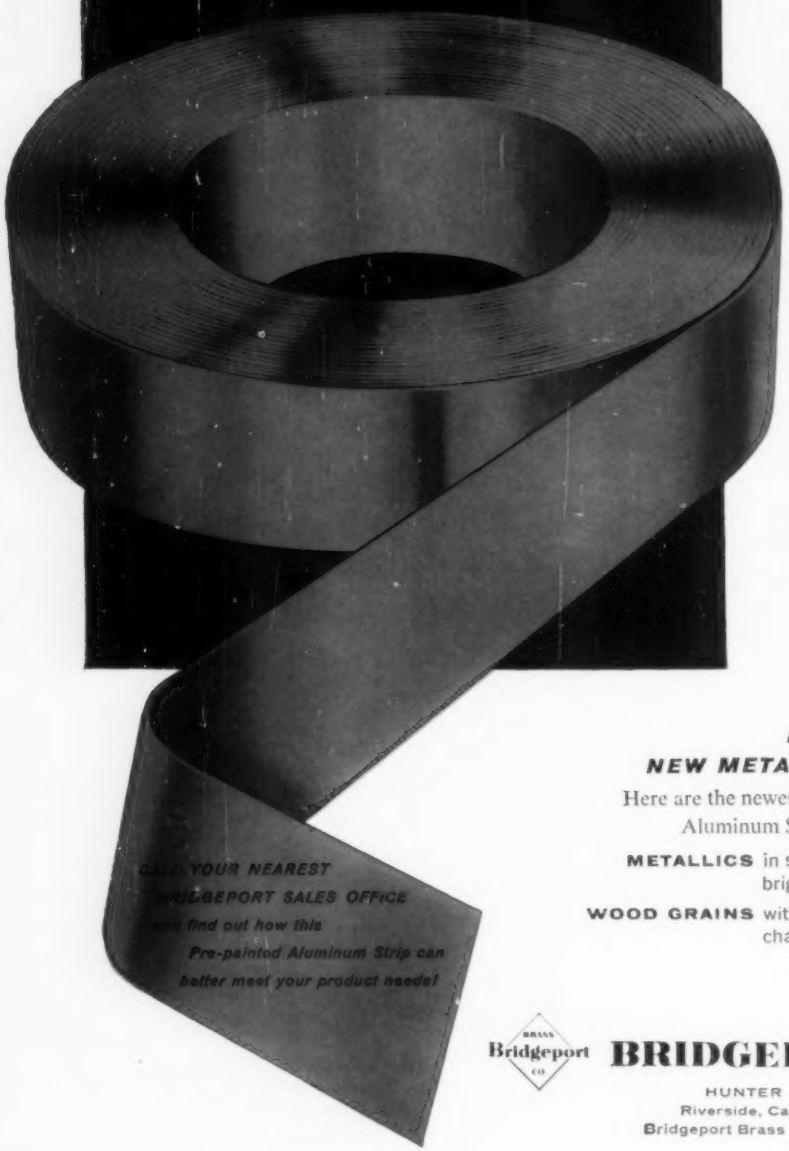
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curves find

COMPRESSION STRENGTH of Thin-Walled Cylinders

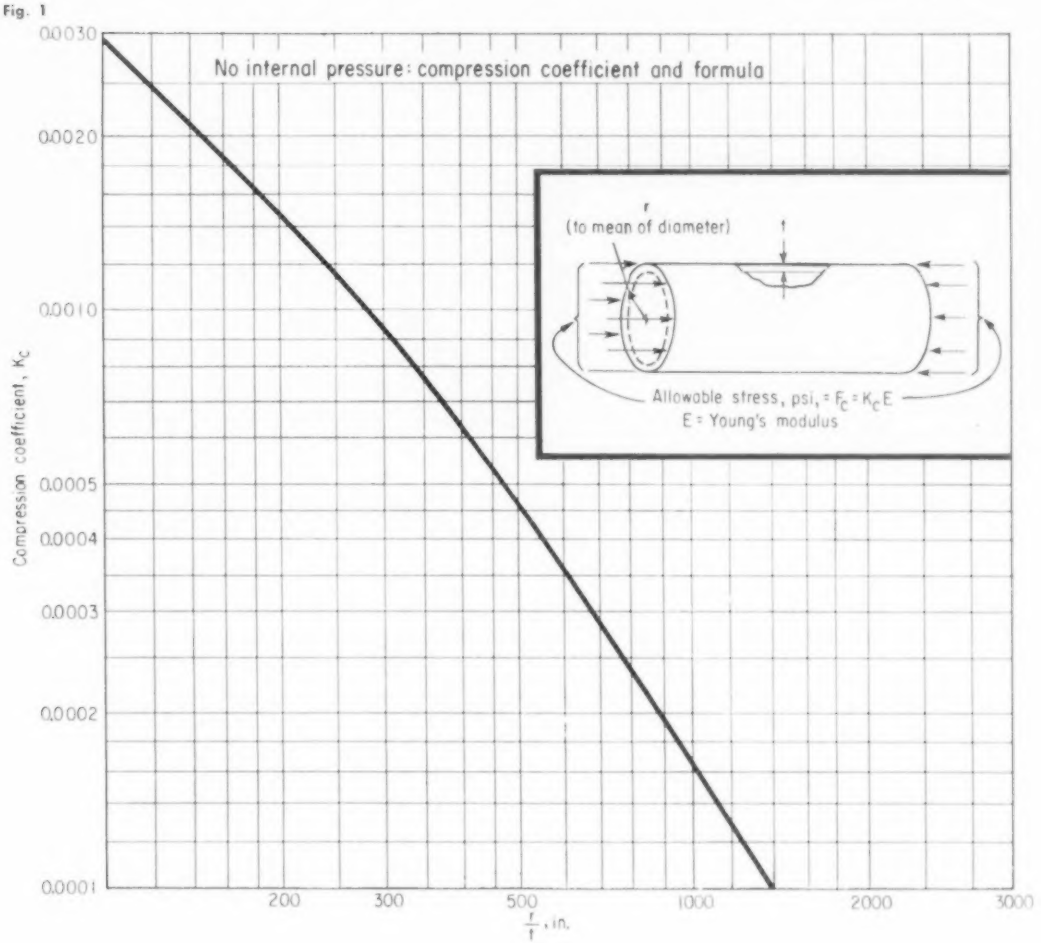
For cylinders, under axial loads, with and without internal pressure. A coming issue will give curves for bending and torsion strength.

IRENE KUSMISS, *Design Engineer, Walter Kidde Co.*

A long cylinder under axial compression may fail either by lateral deflection as a column (primary buckling), or by a local wrinkling and collapse of the thin walls (local buckling). The curves given here cover local buckling that occurs in the elastic range of the cylinder material.

(continued on page 79)

Fig. 1



US RUBBER **PowerGrip** "TIMING" BELT

Put reliance on this low-cost belt for your appliance

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SAVE the "Timing" Belt is reliable—it always works

SAVE with simpler design and fewer units

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The U. S. PowerGrip "Timing"® Belt has an efficiency of close to 100%. That's why the makers of many kinds of appliances can now combine simplicity of design with split-second response. PowerGrip has no slippage, no take-up—allows short and fixed centers, high ratios. No need for lubrication or housing devices, because there is no metal-to-metal contact. *Quiet!* Handles speeds up to 16,000 f.p.m. or so slow as to be imperceptible to the eye. *Vibrationless!* Simplify and improve your power transmission unit with U.S. PowerGrip "Timing" Belts.

These unique transmission belts are available, along with expert engineering service, at your "U.S." power transmission distributor, or by writing us at Rockefeller Center, New York 20, N. Y. In Canada, Dominion Rubber Co., Ltd.

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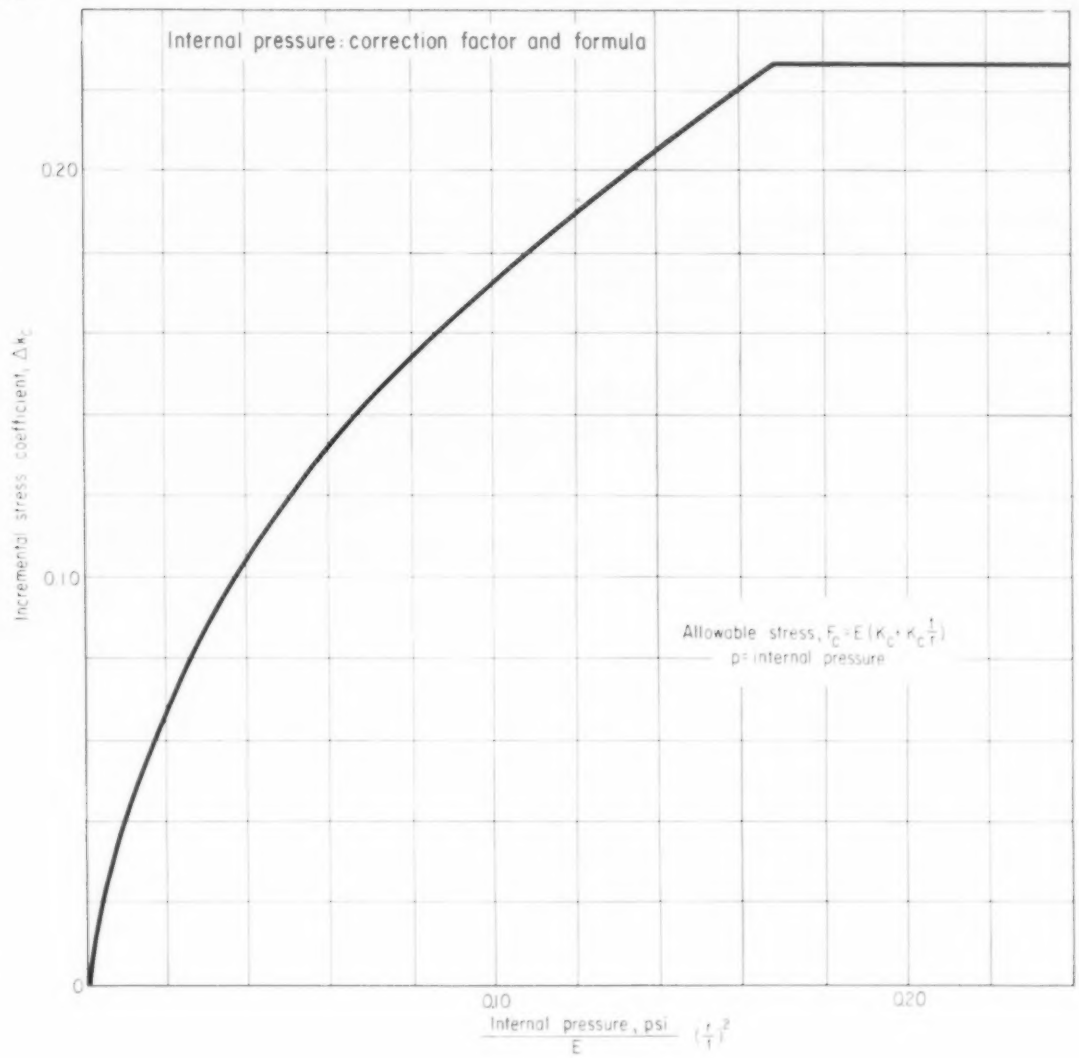
COMPRESSION STRENGTH

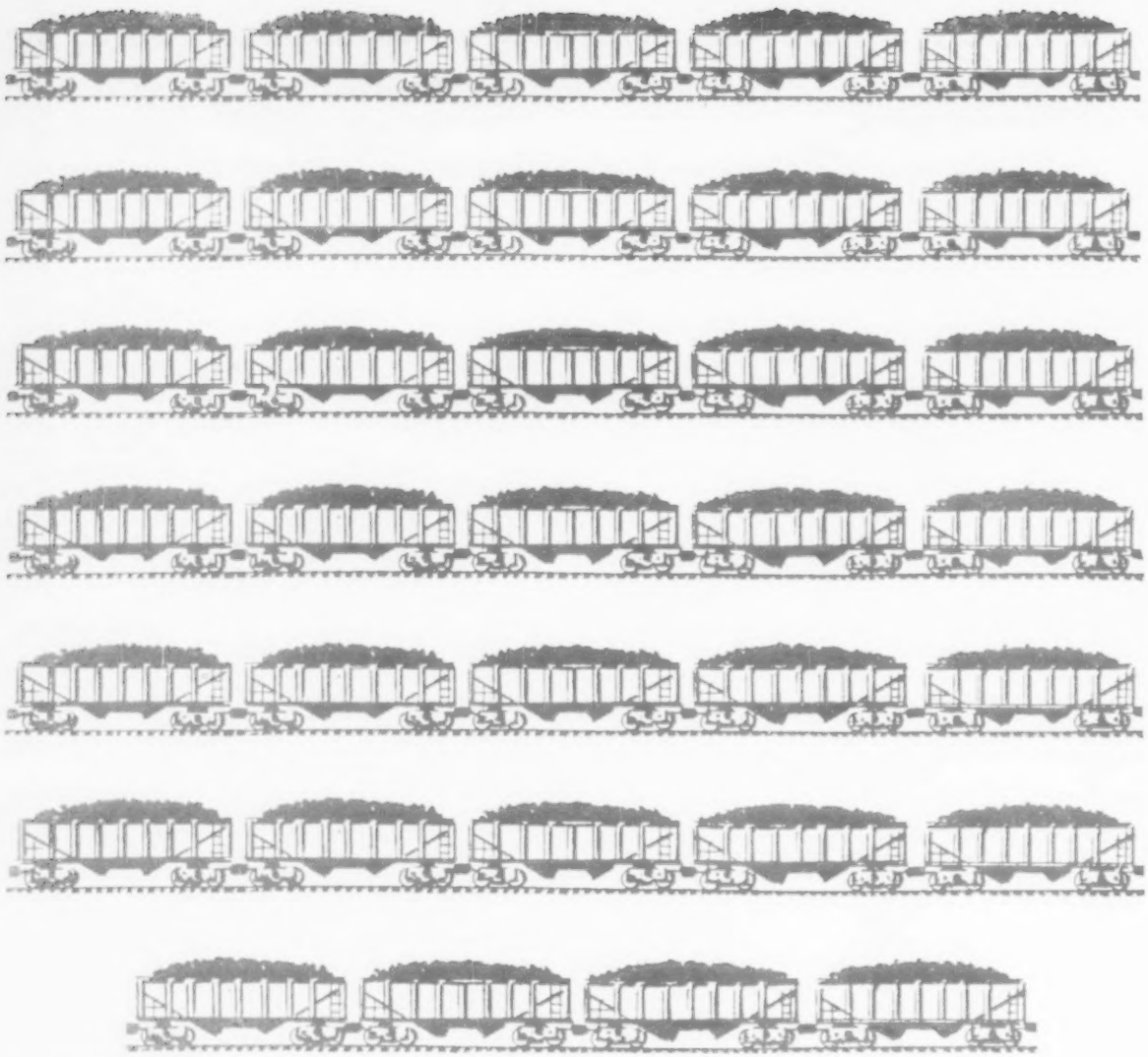
of Thin-Walled Cylinders

Literature on the subject gives many theoretical derivations of critical buckling stresses of thin-walled cylinders for various types of loading. But observed buckling loads often do not correspond to these theoretical values; in almost every case the experimental buckling loads are lower than predicted.

These curves are empirical and well substantiated by tests. They can be used in preliminary design of cylinders longer than 3.4 times radius r multiplied by thickness t. When there is internal pressure, both curves are needed—(1) finds stress when there is no internal pressure, and (2) supplies correction factor.

Fig. 2





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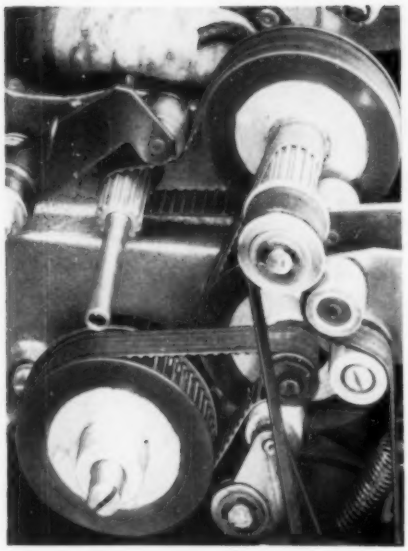
NEW COMPONENTS and MATERIALS



Miniature gear belts . . .
effect a 60:1 reduction in three steps in application shown. The belts minimize backlash, are lighter in weight and provide slipproof action for high and low speeds. Unaffected by humidity, they are said to be noiseless in operation. Belts are now being used in a lightweight portable microfilm camera, replacing nylon gear trains. Prices start at 20 cents for quantity orders. Standard units available from stock. **Russell Mfg. Co., Middletown, Conn.**

Circle 2, inside back cover

Power/manual brake valve . . .
is incorporated in one housing that meets military specs for Type V brake systems. This unit makes transitions from power to emergency manual operation on increasing or decreasing system pressure without loss of brake pressure and will generate a brake pressure equivalent to manual power input, even after complete loss of system pressure. Port sizes are $\frac{1}{4}$ and $\frac{3}{8}$ in. Standard operating pressure is 1,500 psi but higher pressure can be used. Priced under $400. 2-mo delivery. **Hydra-Power Corp., 10-12 Pine Court, New Rochelle, N. Y.**

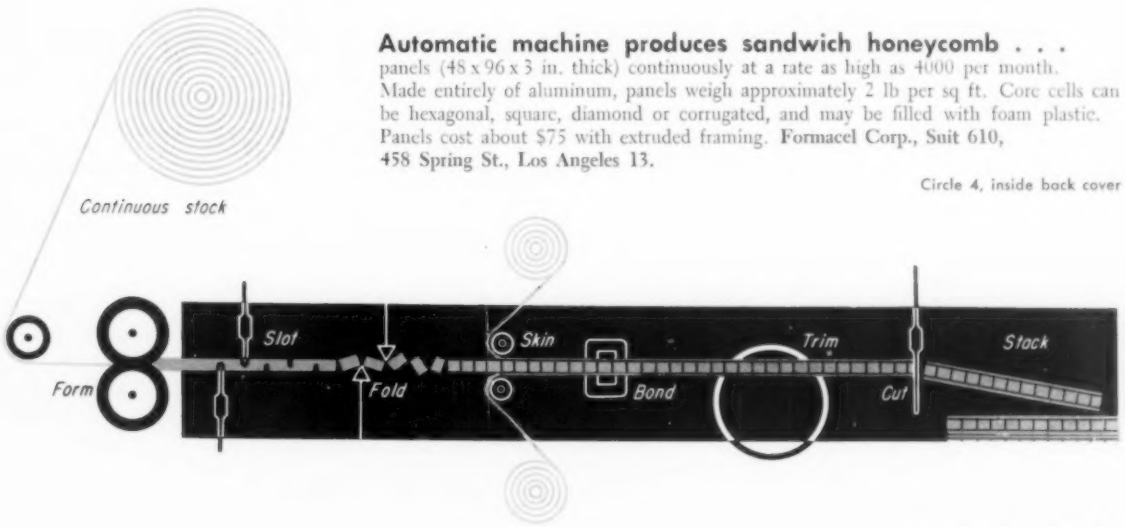
Circle 1, inside back cover

Rotary air motor for fhp . . .
requirements to $\frac{1}{4}$ hp is available in three basic (no load) speeds: 20,000, 5,000 or 1,000 rpm. Develops up to 36 in.-lb of stall torque. An adjustable plug-type regulating valve permits changing speed and torque in any of three standard units. Motor and gearing are designed for lubrication with a fine mist of oil provided by an airline lubricator. Muffler installed on front of spindle case is said to keep noise level to a minimum. Motor is $7\frac{1}{8}$ x $1\frac{3}{4}$ in. dia at mounting lugs. For continuous or intermittent duty applications. Prices begin at $70. Available from stock subject to prior order. **Gardner-Denver Co., Quincy, Ill.**

Circle 3, inside back cover

Automatic machine produces sandwich honeycomb . . .
panels (48 x 96 x 3 in. thick) continuously at a rate as high as 4000 per month. Made entirely of aluminum, panels weigh approximately 2 lb per sq ft. Core cells can be hexagonal, square, diamond or corrugated, and may be filled with foam plastic. Panels cost about $75 with extruded framing. **Formacel Corp., Suit 610, 458 Spring St., Los Angeles 13.**

Circle 4, inside back cover



. . . CONTINUED ON PAGE 82

Laminated epoxy tubing . . .

offering improved electrical and mechanical properties is available in most cross-section shapes in sizes from 0.062 to 6 in. ID; tubing walls as thin as 0.008 in. and in lengths up to 9 ft. Tubing, produced by a method of pressure and vacuum impregnation followed by a curing procedure, is said to have smooth walls and near-perfect concentricity throughout length. Axial compressive strength is reported at 20,000 psi; tensile strength, 41,000 psi. Water absorption after 24-hr immersion is said to be 0.20%. Price is $66.30 per 100 ft for $\frac{1}{16}$ ID x $\frac{3}{32}$-in. wall tubing, against $87.50 for comparable length of NEMA Grade G5 laminated tubing, now considered standard for electrical and mechanical applications. Tubing is also available with coated OD or ID. **Lamtex Industries, Inc., 51 State St., Westbury, N. Y.**

Circle 5, inside back cover

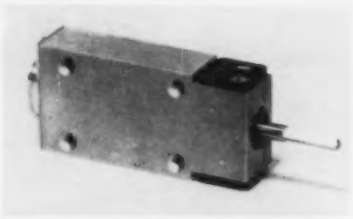
Electronic voltmeters . . .

are self-contained and require only as much panel space as 4½-in. meters. Single-range vacuum tube voltmeters are designed for applications where their high input resistance will not affect circuits being monitored. Barrels are 4⅜ in. deep over-all for mounting. Accuracy is said to be 2% of full scale deflection, except ac voltmeters operating above 50-kc frequency, which have 3% accuracy. Dc line is offered in seven standard ranges, 0 to 1, 3, 10, 30, 100, 300 and 1000 v. Ac line is furnished in 10 standard ranges, 0 to 10, 30, 100 and 300 milliv and 0 to 1, 3, 10, 30, 100 and 300 v rms. Ac meters operate at frequencies from 20 cps to 100 kc. **Metronix, Inc., Chesterland, Ohio.**

Circle 6, inside back cover

Thin motor permits stacking . . .

of multiples in a relatively short length. The permanent-magnet, ball-bearing motor, $\frac{7}{16}$ x $\frac{37}{32}$ x $1\frac{7}{8}$ in. long, is designed to meet military requirements on humidity, salt spray, shock, vibration and fungus. Weight is 1.7 oz. Unit produces starting

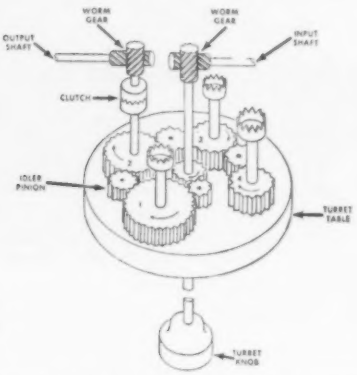


torques to 1 in.-oz, depending on rating, and can be used in intermittent or continuous duty applications, as required. Offered in a variety of armature windings to accommodate systems voltages from 3 to 50 v dc; also to provide desired speed under specific operating conditions. **Globe Industries, Inc., 1784 Stanley Ave., Dayton 4, Ohio.**

Circle 7, inside back cover

In-line speed reducers . . .

for mounting in instrument drives and laboratory breadboards have repeatable ratios available up to 1000:1. Recommended for continuous duty to 1500 rpm, intermit-



tent to 3000 rpm, with output torque capacity to 50 oz-in. Turret-mounted gear train may be rotated to select any of 10 output ratios by pulling and turning selector knob. Pulling selector knob uncouples input drive shaft, allowing ratios to be changed without stopping input shaft rotation. Shafts are ¼ in. stainless. **Insco Co., Div. Barry Controls, Inc., Groton, Mass.**

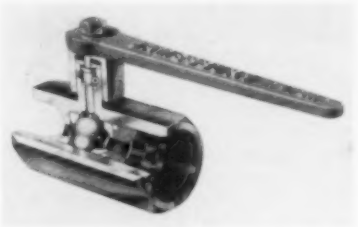
Circle 8, inside back cover

Float-operated filter . . .

separates moisture and other contaminants from compressed air lines. Units operate from 10 to 250 psi, with either continuous or intermittent flow, with small pressure drop and no flutter. Float triggers moisture discharge, rather than actuating port. A built-in impregnated felt cartridge protects operating parts against rust and grit and because the air itself blows out con-

taminants, particles cannot settle on soft seat when drain closes. Available with metal or transparent bowl for pipe lines from ¼ to 8 in. **Wilkerson Corp., 1656 W. Girard Ave., Englewood, Colo.**

Circle 9, inside back cover



High-pressure valves . . .

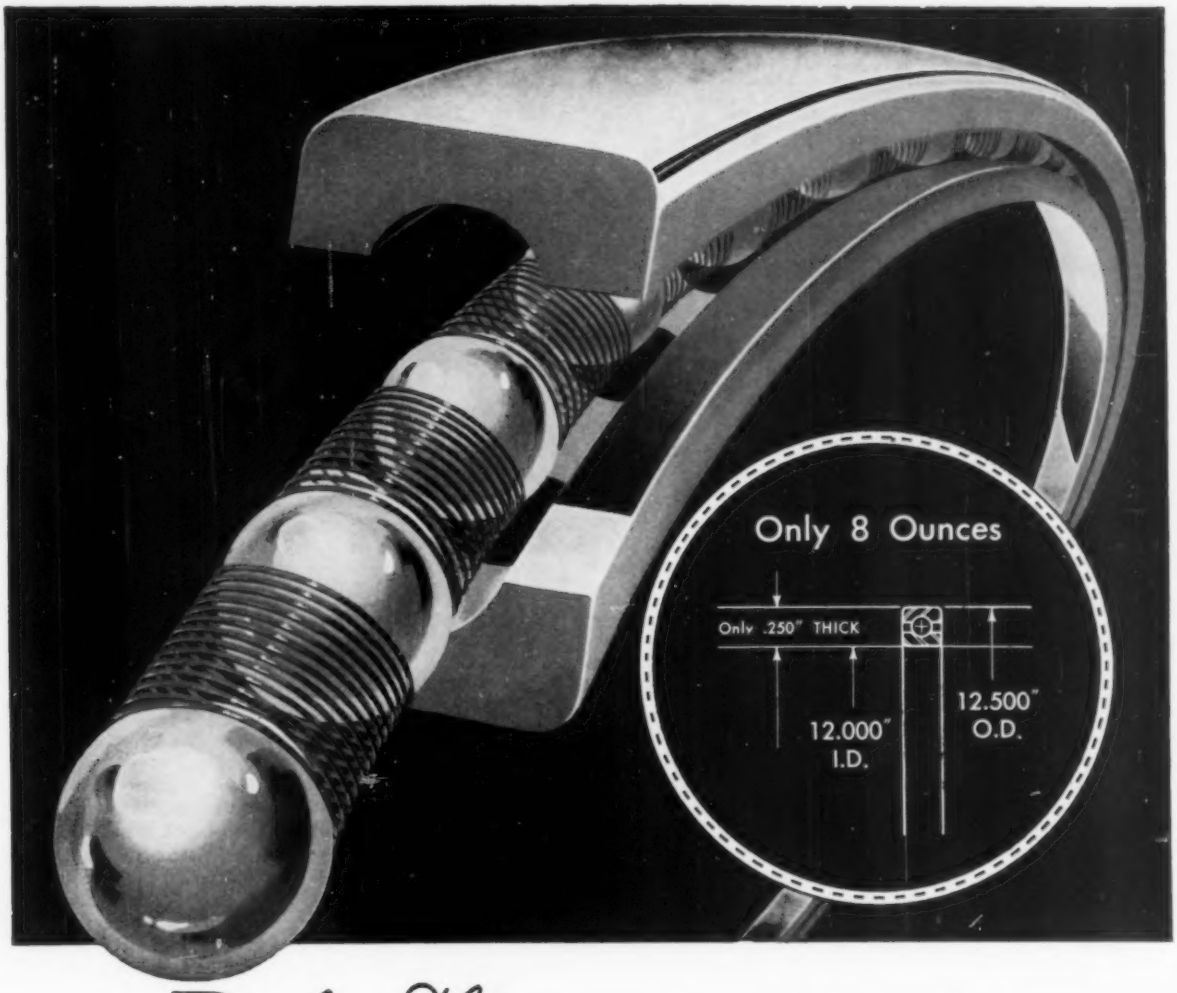
in ¼ to 1½-in. sizes for straight tubing threads and ½ to 2 in. for standard pipe threads are recommended for use on hydraulic equipment and in systems using compressed gases. Available with carbon steel, 303 and 316 stainless steel bodies, with nylon or Teflon seats and seals. Primarily for on-off high-pressure service, they may be also used for high-vacuum service and wherever any type of leakage would be hazardous. Valves offer on-off quarter-turn operation, full-flow and double seal construction. **Jamesbury Corp., Dept. H, Worcester, Mass.**

Circle 10, inside back cover

Plug-in transistor drive . . .

for hydraulic valves in control systems consists of a 150-milliw power amplifier coupled to a solid-state, phase-sensitive demodulator. Transformers and other frequency-sensitive elements are eliminated,

. . . CONTINUED ON PAGE 84



Reali-Slim...by Kaydon
world's thinnest radial ball bearing

HERE'S a typical example of Kaydon's *Reali-Slim* unique radial ball bearing that's finding wide application in practically every industry. *Reali-Slim* are the world's finest thin-section bearings and proportionately are thinner than a wedding ring. The bearing illustrated here is 12.000" I.D., 12.500" O.D., .250" thick — weighs less than 8 ounces. Designed for minimum weight and space limitations, it has a static load capacity of 5,520 lbs. and 894 lbs. at 100 rpm.

If you're looking for *Reali-Slim*, lightweight, radial ball or roller bearings, look at Kaydon's *Reali-Slim* line. Besides hundreds of standard *Reali-Slim* designs, there's a wide variety of special races, seals and separators to meet special bearing problems. What's more Kaydon is able to produce these *Reali-Slim*, high-precision bearings because Kaydon specializes in the unusual. In addition, Kaydon bearing engineers are prepared to give you valuable help with technical bearing application problems.

For complete data on *Reali-Slim* bearings for standard or special applications, ask for engineering Catalog No. 54RS-2.

***Reali-Slim* Ball Bearings** — in Conrad, angular contact, 4-point contact and other types are available in seven standard cross sections from .250" to 1" and in bore diameters from 4" to 40".

***Reali-Slim* Roller Bearings** — in radial or taper roller types are available in cross sections from 5/16" and in bore diameters from 5" to 40".

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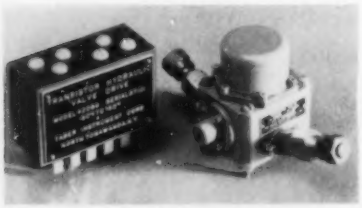
All types of ball and roller bearings — 4" bore to 178" outside diameter...
Taper Roller • Roller Thrust • Roller Radial • Ball Radial • Ball Thrust Bearings



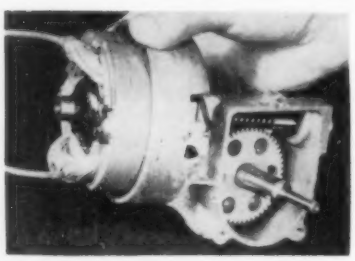
permitting satisfactory operation over a frequency range of 0 to 10 kc. Device requires a 5-milliw input signal. It is said to be capable of driving a hydraulic valve to full output from an input signal of 3 mv across 100 ohm. Operates in temperatures of −58 to 122 F. Size is 3 x 1⅜ x 2⅛ in.; weight is 12 oz. Unit is priced at $140. **Taber Instrument Corp., North Tonawanda, N. Y.**

Circle 11, inside back cover

Severe-duty brake motors . . .

in ratings from ½ to 3 hp for use in chemical atmospheres and areas where highly corrosive or excessively moist conditions are encountered. The enclosed, nonventilated, fan-cooled units feature cast iron construction, protective washers under through-bolts, a completely gasketed conduit box to prevent entry of foreign matter, and a rotating neoprene shaft seal impervious to most chemicals. **General Electric Co., Schenectady 5.**

Circle 12, inside back cover



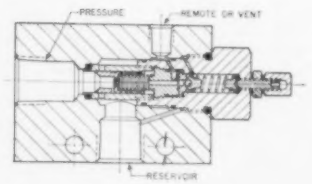
1/15 hp gear motor . . .

for built-in applications requiring few daily operations. Operates with an output of 395 rpm through a 25.5:1 gear ratio. Can be adapted to a 51:1 ratio. Has cast aluminum case, steel shaft, bronze reduction gear and bronze bearings. It is rated 115 v at 60 cps. Dimensions are about 5 x 5 x 7 in. Suitable for appliances. **General Electric Co., Schenectady 5.**

Circle 13, inside back cover

Remote pilot relief valve . . .

maintains constant relief pressure in hydraulic circuits. Remote valve is set to open at required pressure while internal pilot valve is set to handle the max pressure produced by the pump. Sliding-spool main valve is held closed by the balanced pressure across an orifice in the spool. When pump pressure exceeds valve setting, pilot flow passes through the spool. This causes the main valve to relieve the tank. Valve maintains close control of system pressures, permitting design of other system parts to close limits. Valve maintains constant relief pressure over a wide range and cracking pressure is 90% or more of max relief pressure. Handles oil to 3000 psi. Available in ¼, ⅜ and 1-in. pipe sizes. **Fluid Controls, Inc., 1284 N. Center St., Mentor, Ohio.**



Circle 14, inside back cover

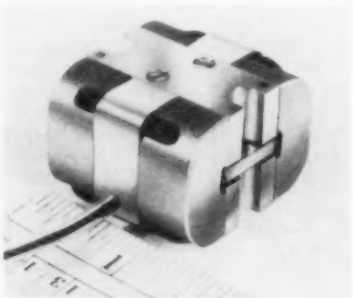
Adjustable-speed dc drives . . .

are packaged to include an enclosed conversion and control panel, an operator's station and an industrial dc motor. Available as a 1-to-40-hp, electronic, adjustable-speed drive and a 1-to-200-hp, magnetic-amplifier, adjustable-speed drive. Drives use static power components to replace conventional motor-generator sets. Conversion units eliminate bearings, brushes, commutators, shafts and coupling of rotary-type dc power sources. Size makes possible savings of up to 50% in space and weight reduction permits wall mounting of many sizes. **Cutler-Hammer, Inc., 296 N. 12th St., Milwaukee 1.**

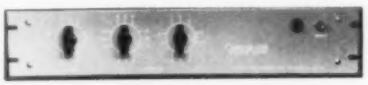
Circle 15, inside back cover

Miniature torque motor . . .

is one of a series of five, all identical in design and construction, and differing only in size and performance capabilities. Model 102 is a high-performance unit, insensitive to environmental conditions. Motor is said to exhibit practically no saturation effects over the normally used regions of current displacement and force. Has efficient performance-to-weight ratio. Unit is 1½ x 1⅜ x 1⅛ in. Weight is 6¾ oz. Output force is ±5 lb, midposition. Output stroke is ±0.007 in. Resonant frequency is 800 cps. Two coils with separate pairs of leadouts have resistance of 11 to 5000 ohm per coil. With proper choice of coils, the motor may be driven from vacuum tubes, magnetic amplifier or transistors. Max power required is 2.75 w. Operates in temperatures of −65 to 350 F. Meets military requirements for shock and vibration, and has high corrosion resistance. **American Measurement & Control, Inc., 240 Calvery St., Waltham, Mass.**



Circle 16, inside back cover



Multiple digital clock . . .

logs time to nearest second. Up to three independent, parallel, decimal outputs are available in one unit, with time resolutions of seconds or minutes. For standard relay rack mounting, unit requires 3½ in. of panel height. Over-all dimensions are 3½ x 19 x 12 in. deep. Clock can actuate all parallel readout devices such as tape printers, parallel punches, digital displays. Parallel output provides an externally wired common lead for each digit position, making conversion to serial mode easy. **Chronolog Corp., Dept. PE, Box 4587, Philadelphia 31.**

Circle 17, inside back cover

Subminiature sealed relays . . .

withstand 30-g vibration at 2000 cycles, 50-g Class II shock and ambient temperatures of −85 to 257 F. Designed for power and low-level switching. Contacts are rated 2 amp resistive at 26.5 v dc and 115 v ac. Balanced rotary armature action and a planned relation of copper to iron are said to produce a magnetic structure with maximum usable torque characteristics. As a result, contact pressures, gaps and follow-up meet shock, vibration and load-handling requirements. Power requirements are low. Relays are available with hook terminals or short or long wire leads. Terminals have 0.2 in. grid spacing. **Struthers-Dunn, Inc., Pitman, N. J.**

Circle 18, inside back cover

Side-indicating voltmeters . . .

offer maximum readability at a desired voltage point and are said to be particularly applicable wherever variations in volt-

. . . CONTINUED ON PAGE 86

A Different Light on the Subject...

Include Price in the Many Advantages Solid Brass Has Over Other Materials

Many concerns are discovering that the availability of solid brass—at competitive prices—makes it extremely advantageous to use in place of other materials.

For example, parts of the desk lamp shown here made by J. Schrader Co., Cleveland, Ohio, are now being made of Bridgeport F-37 Ultra Fine Grain Brass Strip. Formerly, these same parts were made from a plated product. Now, with solid brass as an active cost competitor, its inherent qualities of workability, beauty and durability over other metals and methods are employed with excellent results.

This is an opportunity that warrants your attention. Your Bridgeport salesman will be glad to show you how solid brass can benefit your product. You'll find that he will work with you in every way. Look into the benefits of solid brass... *including its cost.*

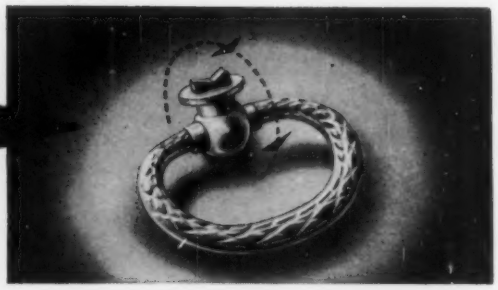
matched Bridgeport Brass Alloys *to your job*

BRIDGEPORT BRASS

Offices in Principal Cities • Conveniently Located Warehouses

Bridgeport Brass Company, Bridgeport 2, Connecticut
In Canada: Noranda Copper and Brass Ltd., Montreal

another unique GRC die cast zinc alloy component



this movable Intercast® element unit was
cast-assembled in one operation
by GRC

GRC's unique, patented INTERCAST method die casts multiple-part zinc-alloy units with moving elements in a single, automatic, time-saving, money-saving elements . . . even continuously interlocked assemblies. Units leave the machine complete, ready for immediate use.

This INTERCAST technique is an ingenious refinement of GRC's exclusive method of small parts die casting—providing broad design latitude, close tolerances, economies in quantities of 100,000 and more.

Let GRC solve your problems. No size too small Maximum length 1¾", maximum weight: ½ oz.
Send for fact-filled bulletin, TODAY.

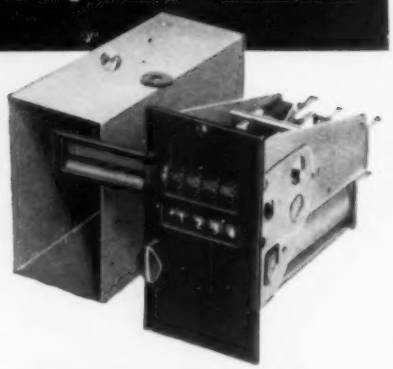
World's Foremost Producer of Small Die Castings

GRIES

GRIES REPRODUCER CORP.
159 Beechwood Ave., New Rochelle, New York • NEw Rochelle 3-8600
CIRCLE 144 READER SERVICE CARD

SODECO'S NEW
Predetermining Impulse Counter

Compact



Measures only 3¼"x 1¾"x 3⅞"
Suitable for flush mounting

CONVENIENT PRESET—
Easily accessible setting wheels

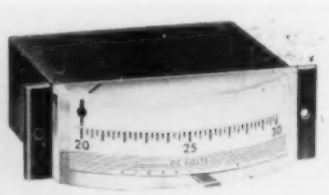
FAST RESET—
Manual, or electric for repeat cycling

S.P.D.T. PREDETERMINING SWITCH—
less than 50 ms switching time

LOWER POWER REQUIREMENT—
Counting at 10 i.p.s.—3.8 W;
at 25 i.p.s.—5.1 W.
Reset—7.6 W, all at 110 V. DC.

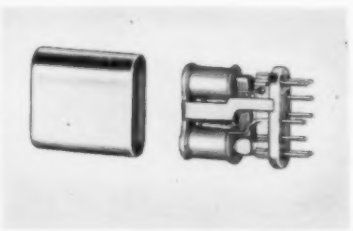
Write today for your copy of Sodeco Bulletin E-25 which gives full technical information.

LANDIS & GYR, INC.
45 West 45th Street, New York 36, N. Y.



age might affect the operation of regulated power supplies, precision measuring units, calibration systems, electro-medical devices and other types of electric and electronic equipment. Scale length and accuracy are reported to be the same as with much larger meters, but occupy about one-third the panel area. Model 1135 has a scale length of 2.1 in. and a panel area of 2 sq in. Model 1145 has a scale length of 2.7 in. and a panel area of 5.5 sq in. Standard full-scale ranges are 4 to 8 v dc, 9 to 15 v dc, 20 to 30 v dc, 70 to 110 v dc, 90 to 140 v dc and 175 to 265 v dc. Current drain is 1.23 ma dc at min scale indication point; 1.76 ma dc at full scale for any voltage range. **International Instruments, Inc., P.O. Box 2954, New Haven 15, Conn.**

Circle 19, inside back cover



Microminiature relay . . .

for low-level circuitry is said to meet applicable military specifications. 2PDT contacts carry rating of 3 amp at 257 F per MIL-R-25018 and 2 amp at 257 F per MIL-R-25018 and MIL-R-5757 C. Hermetically sealed unit is suitable for continuous duty service. Altitude test is 80,000 ft. Compression glass headers with flattened and fluted pins prevent turning. Also offered with solder hooks. Only solder connections in relay in coil lead to header pins or hooks. Measures 0.844 x 0.781 x 0.344 in. deep. Weight is 0.35 oz. Said to be priced low in quantities. **Guardian Electric Mfg. Co., 1621 W. Walnut St., Chicago 12.**

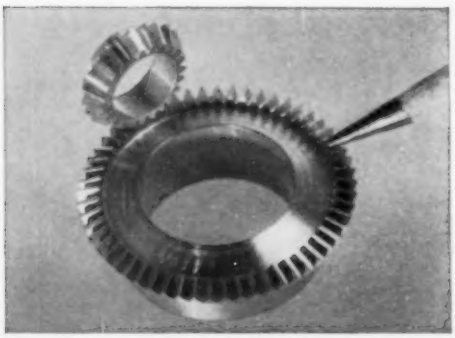
Circle 20, inside back cover

Single-element pushbuttons . . .

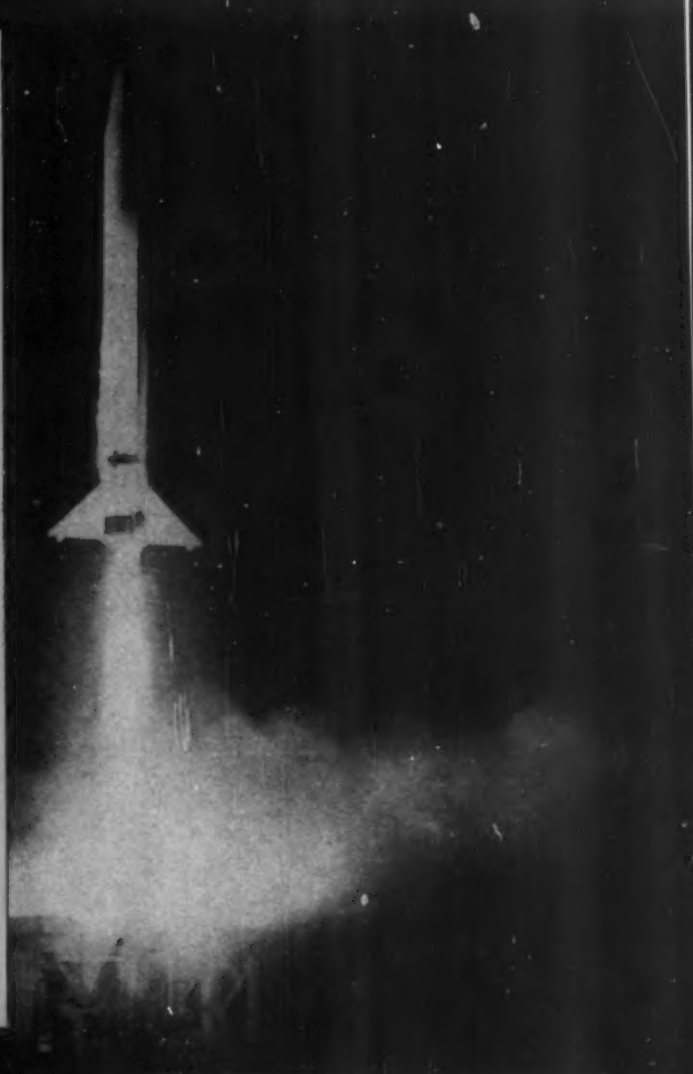
for standard-duty, general-purpose ac and dc control circuits are intended for individual or flush panel mounting in non-oiltight applications. Black, molded

(Continued on page 88)

CURVIC COUPLINGS provide an accurate, light, compact, and self-contained connection in which the teeth both center and drive. The Curvic design represents a new standard in the application of coupled parts.



BEVEL GEARS



When a gear or a coupling determines the *accuracy of trajectory* . . .

When a missile or rocket works on paper the best way to get it into the air is to see to it that all the parts agree with the paper work.

And when one of those parts is a bevel gear or coupling, Gleason engineers can help you three ways:

1. Engineering service. Our full staff of engineers is ready at all times to help you develop bevel gear combinations and Curvic® Coupling designs. They can help you make sure that either part meets your specifications.

2. Machines to cut or grind to your tolerances. You can produce any fine pitch gear—spiral bevel, hypoid, Zerol® or Coniflex®—precisely and economically with any of five Gleason machines.

No matter how rigid your specifications or the size of your parts, our engineers can help you select the right machine or combination of machines for 100% accuracy.

3. Complete testing equipment. We have engineered a series of testers for making certain that all parts do meet your critical specifications. For example, on the Gleason No. 104 Hypoid Tester you obtain a permanent test record to help you match pairs properly and to keep a graphic record of the rolling qualities, tooth spacing, and concentricity of your parts.

Any or all of these services are yours for the asking at any time.

GLEASON WORKS

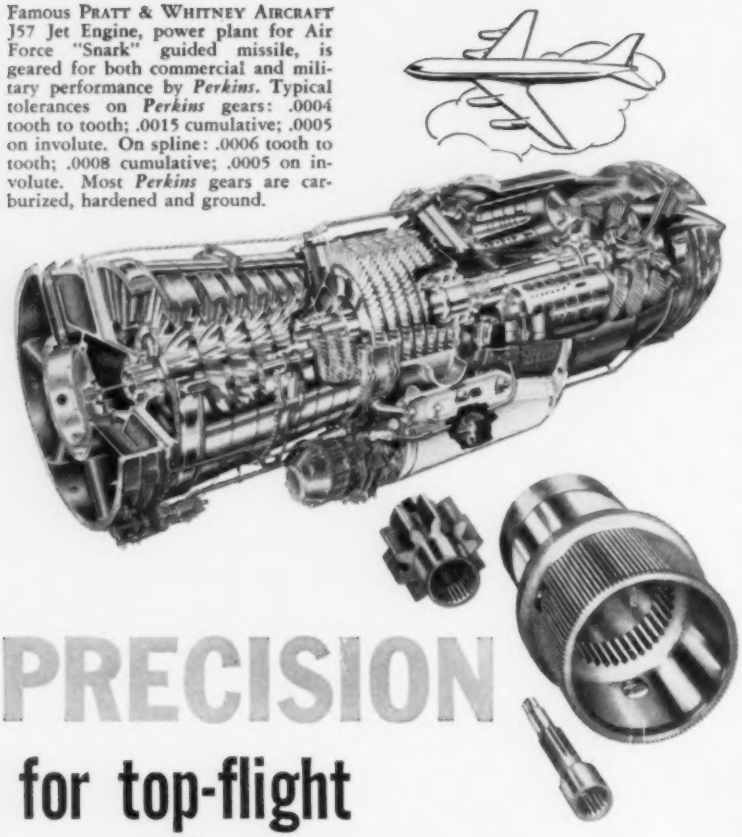
Builders of bevel gear machinery for over 90 years

1000 UNIVERSITY AVE., ROCHESTER 3, N.Y.

71

CIRCLE 145 READER SERVICE CARD

Famous PRATT & WHITNEY AIRCRAFT J57 Jet Engine, power plant for Air Force "Snark" guided missile, is geared for both commercial and military performance by *Perkins*. Typical tolerances on *Perkins* gears: .0004 tooth to tooth; .0015 cumulative; .0005 on involute. On spline: .0006 tooth to tooth; .0008 cumulative; .0005 on involute. Most *Perkins* gears are carburized, hardened and ground.



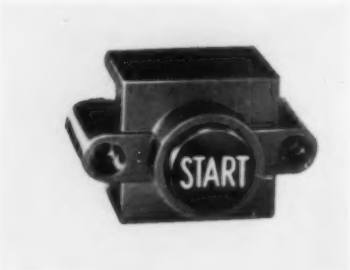
PRECISION for top-flight performance!

Rigid PRATT & WHITNEY AIRCRAFT precision requirements spell *performance* . . . top-flight performance. Reason: The future is at stake. And that future can well ride on gear teeth. Since 1940, PRATT & WHITNEY AIRCRAFT gear tolerances have been *Perkins'* standards . . . for commercial gears as well as aircraft. Such precision pays off in longer wear, greater efficiency, lower maintenance cost. That type of precision can pay off for you, too.

This Handy Gear Calculator, easy to use, saves time. *Folder* illustrating Perkins custom precision gears and facilities offers information. Both yours on request.

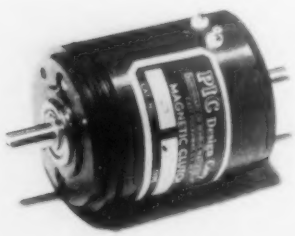
PERKINS
MACHINE AND GEAR CO.

Dept. 52 West Springfield, Mass.
Telephone: REpublic 7-4751



phenolic base contains momentary double-break silver-to-silver contacts rated at 3 amp, 120 v ac. Standard button markings are engraved and white-filled. **Ward Leonard Electric Co., Mount Vernon, N. Y.**

Circle 21, inside back cover



Magnetic clutches . . .
and clutch brakes with output torques to 16 oz-in. are available in black anodized cases with stainless steel shafts and bearings, all of which meet military specifications. Offered in Mark 14 or size 11 frame diameters, 1⅛ in. dia. Power consumption is 3 w. **Pic Design Corp., 477 Atlantic Ave., East Rockaway, N. Y.**

Circle 22, inside back cover

Solenoid valves . . .
normally open or normally closed are fully automatic, 2-way, packless, bronze-bodied and pilot-operated. In sizes ⅜ to 3 in. Valves are for heavier liquids, air and gases to 400 psi; steam to 200 psi; temperatures

(Continuedon page 90)

Reliability

Yarn control of the Cobble Bros.' Tufting Machine is through electrical contact fingers which transmit impulses to 120 CLARE RELAYS each controlling two electro-magnetic clutches.

That's why

COBBLE BROS.' controls were designed around Clare Relays

"The most important reason Clare Mercury-Wetted-Contact Relays were chosen as the basic components for this control is their *reliability*."

Assurance of billions of trouble-free operations caused engineers of Cobble Bros. Machinery Co. to design their electrical control system around Clare HG relays.

There are 120 Clare HG Relays in controls of the Cobble Yardage Tufting Machine shown. They receive impulses from 120 electrical contact fingers as they "read" the pattern. The relays operate electro-mechanical clutches to translate these impulses into intricate carpet designs.

Reliability means freedom from costly maintenance. If, like Cobble Bros.' engineers, you want only the best for your design, let us tell you ALL about Clare Mercury-Wetted-Contact Relays. Address: C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare Canada Ltd., 2700 Jane Street, Toronto 15. Cable address: CLARELAY.

CLARE RELAYS

FIRST in the industrial field

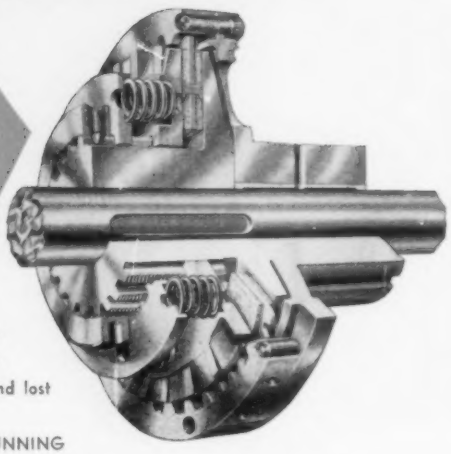
Each relay is housed with a transistor in this modular type unit. The module is then plugged into the control system.

• • •

Send for Clare Bulletins 120 and 122

HILLIARD *Clutches*
FOR POWER CONTROL DESIGN

ADJUSTABLE *Slip Clutch*



- PROTECTS against overload, jams and down time.
- RESUMES THE DRIVE AUTOMATICALLY after overload.
- ELIMINATES SHEAR PINS and lost time.
- ADJUSTABLE - WHILE - RUNNING feature is available.

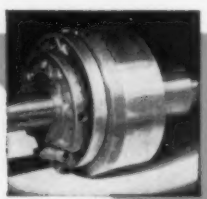
Hilliard Slip Clutches are continuously protecting the drive on dish washing machines—printing presses—packaging machines—case loaders—foundry equipment— air filters—conveyors—overhead doors—and many others.
They maintain steady torque while permitting speed variation on fabric drying drums, steel strip slitters and similar equipment.

The adjustable-while-running types are used to maintain constant tension on rewind stands for paper coaters, textile machines, rope, steel and wire mills and for drive systems requiring overload protection but which must be disconnected at times.

WRITE TODAY FOR BULLETIN 300 WITH COMPLETE INFORMATION.

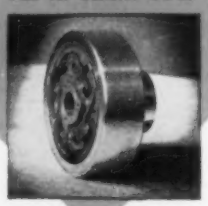
● OTHER HILLIARD CLUTCHES ●

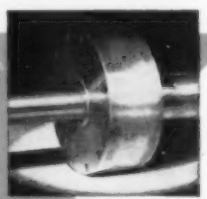
CONSIDER AUTOMATION - INVESTIGATE THESE PRODUCTS



SINGLE REVOLUTION CLUTCHES for automatic accurate control—electrical or mechanical—of intermittent motion, indexing, cycling and cut-off. Ask for Bulletin 239.

HILLIARD - TWIFLEX CENTRIFUGAL COUPLING for smooth, easy starting of any load automatically with overload protection and ability to accommodate shaft misalignment. Ask for Bulletin CE-3.





OVER - RUNNING CLUTCHES for automatic instantaneous engagement and release on two speed drives, dual drives and ratchet, or backstop action. Ask for Bulletin 231.

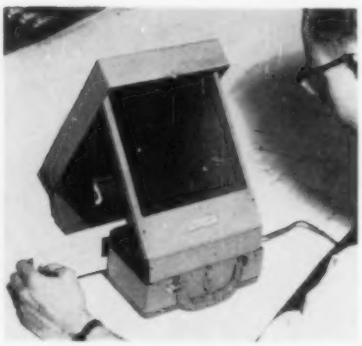
THE HILLIARD *Corporation*

MANUFACTURING CLUTCHES FOR OVER 50 YEARS

101 WEST FOURTH ST., ELMIRA, N. Y.
IN CANADA: UPTON-BRADEEN-JAMES, LTD.

to 450 F. Heavy-duty coil assembly handles heavier fluids. Valves have unbreakable piston rings, waterproof epoxy resin coil and guided pilot valve seat. **J. G. Gould Co., 4707 Massachusetts Ave., Indianapolis 18.**

Circle 23, inside back cover



Portable microfilm readers . . .

for engineering, office and field service include a portable mechanical unit that is priced at $59.50 and a hand viewer that costs $5.50. Made for D-size aperture cards, portable unit enlarges microfilm frame on an 8 x 8-in. screen. Magnification is about six times. It stores about 200 cards. Dimensions, closed, are 12 x 9 x 4 in. A 50-w lamp is used, without a cooling system. Operates on ac or dc. Hand viewer is a magnifier with two lenses and a plastic mount. Magnification is three times. **Filmsort Co., Pearl River, N. Y.**

Circle 24, inside back cover

Positive intermediates . . .

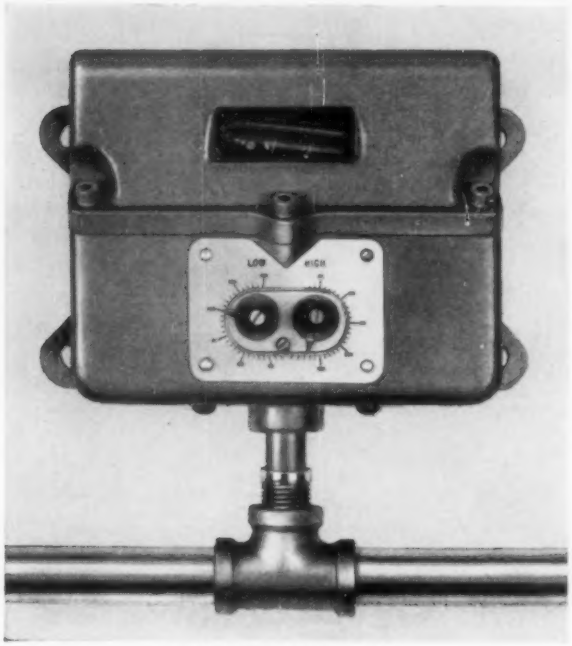
and negatives for printing engineering whiteprint intermediates are produced by contact on a new base in solutions of D-72 type. Developing is done in 1 to 2 min and developed materials are said to be free of pinholes and to provide positive line images in clear, sharp black. Can be safely handled in subdued light. Positive intermediates are for use in diazo machines. Negatives of same material are for printing on vellums, washoff cloths and photo cloths. Available in standard cut sizes and in 100-ft rolls, 36 or 42 in. wide. Roll prices are $68.95 and $78.95, respectively. **Anken Chemical and Film Corp., Newton, N. J.**

Circle 25, inside back cover

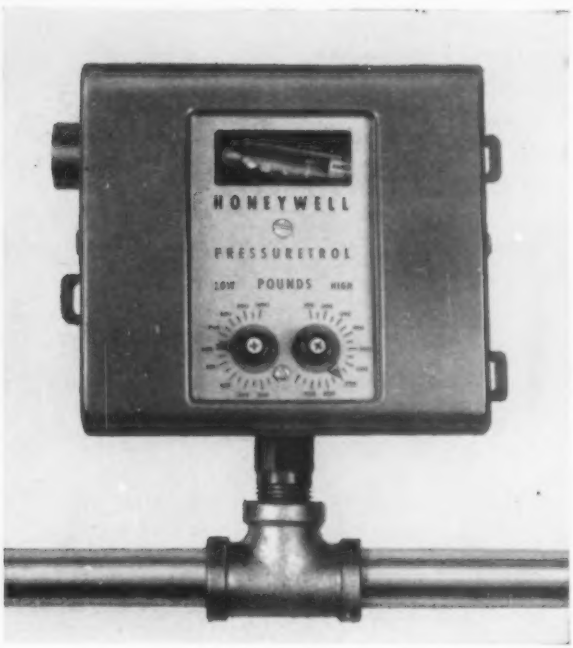
Transistor breadboarding kit . . .

includes a phenolic board predrilled to accommodate terminals and sockets, 20 push-in type lugs for component wiring, 4 round sockets and rings for mounting, 4 rectangular sockets and 4 clamps for flat mounting. Accessories include an as-

(Continued on page 94)



Explosion-Proof *Pressuretrol*



Pipe-Mounted *Pressuretrol*

Here's the pressure switch you asked for... the

NEW HONEYWELL PRESSURETROL*

The rugged new P428 Pressuretrol is designed specifically for industrial use. Use it for gas or liquids at pressures to 3000 psi. Use it as a controller or as a high or low limit device. Its outstanding features are:

- **Convenient adjustment**—With set point and differential knobs located on the front of the case for maximum visibility and accessibility.
- **Visible switch position**—Window in front of case reveals at a glance whether mercury switch is made or broken.
- **Bourdon tube actuation**—Tube of beryllium copper or stainless steel depending on range.
- **Rugged, attractive case**—Made of drawn steel with die-cast cover, case resists dust, weather, corrosion. Harmonizes well with other instruments when panel mounted.
- **Explosion-proof model**—Enclosed in its own integral case with external settings—not necessary to open case or break electrical connection. It is small and compact, and requires no special housing or setting extensions . . . provides positive protection when used with hazardous gases or in hazardous atmospheres.

Panel-Mounted *Pressuretrol*

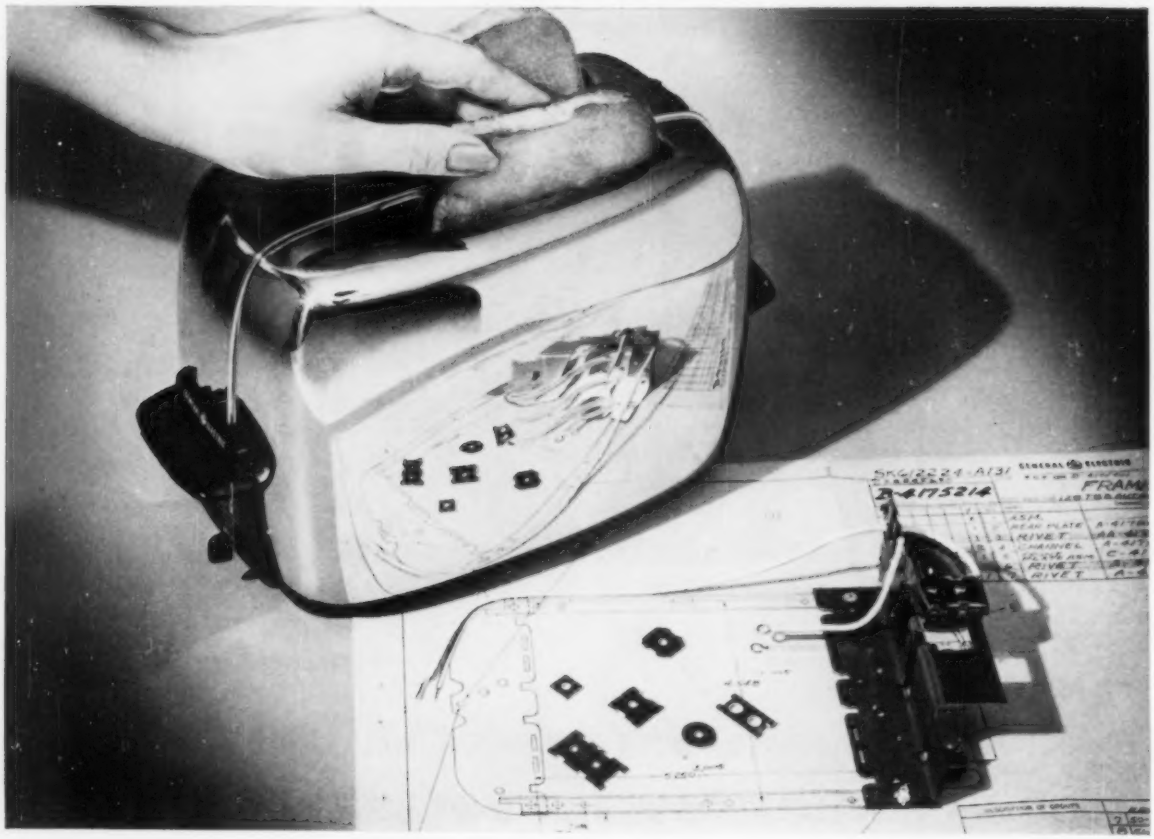
For complete details, call your Honeywell field engineer. He's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

**Trademark, Minneapolis-Honeywell Regulator Co.*

Honeywell

First in Control

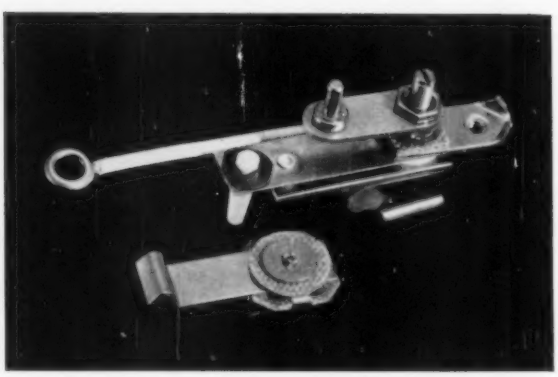


6 Taylor-Fabricated Laminated Plastic Insulators Protect Control Elements of GE Automatic Toaster

These insulators for the pop-up mechanism, color control unit, and heating element in the General Electric Automatic Toaster are made of continuous filament woven glass fabric with melamine resin bond. This Taylor Fibre Co. material was selected for its ability to withstand the temperatures encountered in the toasting operation, its excellent arc resistance and mechanical strength, and its cost, which is lower than that of the mica insulators formerly used.

Another factor in the decision was the capacity of Taylor Fibre Co. to produce the fabricated parts to specification, and in the large quantities required, at reasonable cost.

You, too, may have applications which can utilize the combination of physical, mechanical and electrical properties found only in laminated plastics. Our application engineers will be glad to discuss them with you, offer engineering assistance, and recommend a Taylor grade that will fit your specific requirements. Our plants at Norristown, Pa., and La Verne, Calif., are both fully equipped for fast supply of basic materials and finished parts. Write us for detailed information or to arrange for a Taylor Fibre man to call on you. TAYLOR FIBRE CO., Norristown 39, Pa.

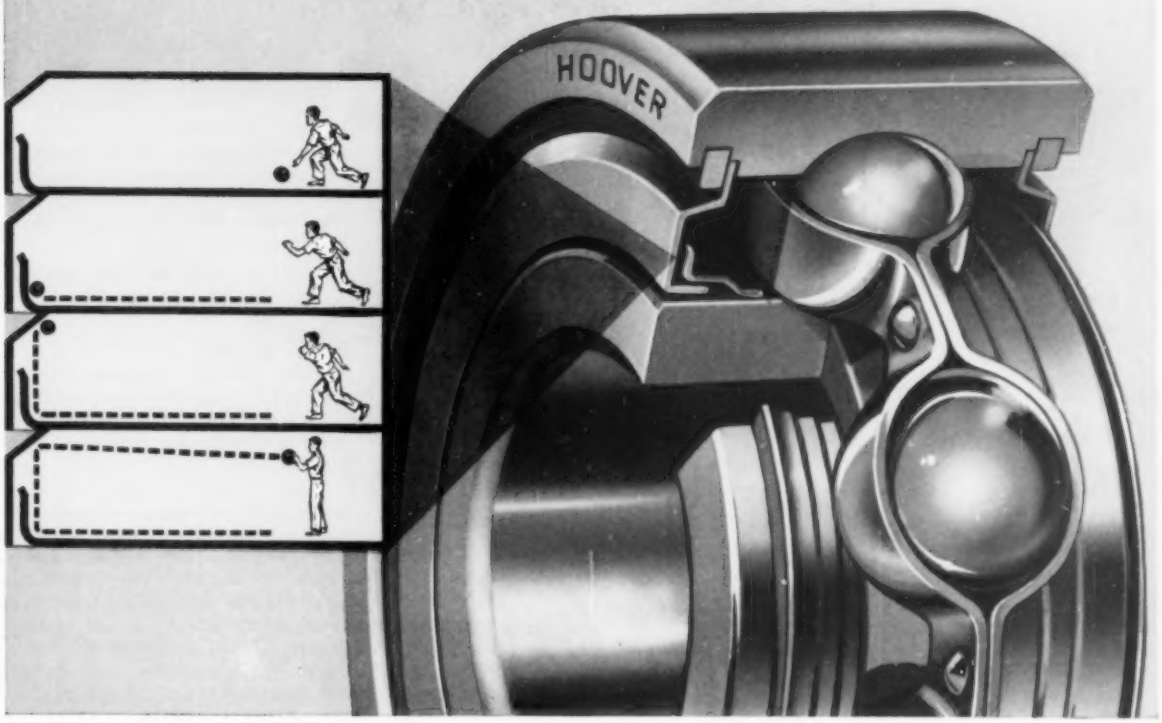


Taylor

LAMINATED PLASTICS VULCANIZED FIBRE

"Slinger Action" Circulates Locked-In Lube

in hoover cartridge bearings with dual labyrinth seals



Depend on Hoover to design a bearing that not only carries a lifetime supply of factory-selected, sealed-in lube, but also circulates the lube so effectively that maximum performance is assured for years. Hoover Dual Labyrinth Seals utilize centrifugal force to return lube again and again to the working surfaces. There is no chance for dirt to enter the bearing. Standard double row bearing width design assures extra large lube capacity. Standard bore and outside diameters simplify installation and replacement problems. Shields are easily removed for relubrication or servicing if required.

Hoover Cartridge Bearings are precision made with super smooth *Hoover Honed* Raceways and *Micro-Velvet* Balls, assuring high load capacity, smooth performance, hushed quietness.

Hoover Honed and *Micro-Velvet* are Hoover Trademarks.

hoover

BALL AND BEARING COMPANY

ANN ARBOR, MICHIGAN

LOS ANGELES SALES OFFICE AND WAREHOUSE: 2020 SOUTH FIGUEROA, LOS ANGELES 7, CALIFORNIA

Hoover Ball and Bearing Company
Ann Arbor, Michigan

Please send your new Bulletin 104, giving complete information on Hoover Cartridge Bearings.

Name_____

Title_____

Company_____

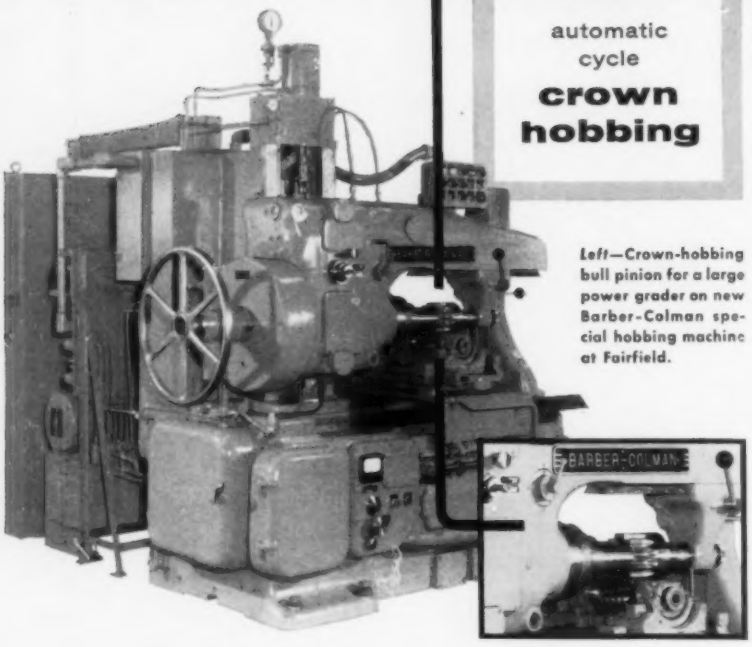
Address_____

City_____ Zone____ State_____

PE-7

another new, ultra-modern
FAIRFIELD GEAR MAKING
facility . . . .

automatic
cycle
crown hobbing



Left—Crown-hobbing bull pinion for a large power grader on new Barber-Colman special hobbing machine at Fairfield.

Saves Time! Cuts Costs! Produces Better Gears *for you*

You get every benefit of latest cost-cutting methods and equipment when your gears are produced by Fairfield. "Automatic Cycle Crown Hobbing" is one interesting example of a new method for generating *accurately* crowned teeth on spur gears and pinions. In addition to significant time savings produced by a remarkably versatile machine, subsequent finishing costs can be reduced, or may be completely eliminated. Special tooth strength characteristics may also be obtained economically.

Check with Fairfield on all of your gear requirements. You get the advantage of high production rates and big volume output in an ultra-modern plant designed exclusively for producing fine gears EFFICIENTLY, ECONOMICALLY. *Call or write.*

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Gears and Differentials for FINE GEARS *Made to Order for:*

TRACTORS • HEAVY DUTY TRUCKS • AGRICULTURAL MACHINERY • POWER SHOVELS AND CRANES
MINING MACHINES • ROAD GRADERS • BUSES • STREET SWEEPERS • INDUSTRIAL LIFT TRUCKS

sortment of socket mounting plates, control mounting plates, transistor mounting kits, panels, rack brackets, dust covers and power supplies. Board is 2⅛ x 4⅛ in. **Specific Products, 21051 Costanso St., Woodland Hills, Calif.**

Circle 26, inside back cover

Power supply . . .

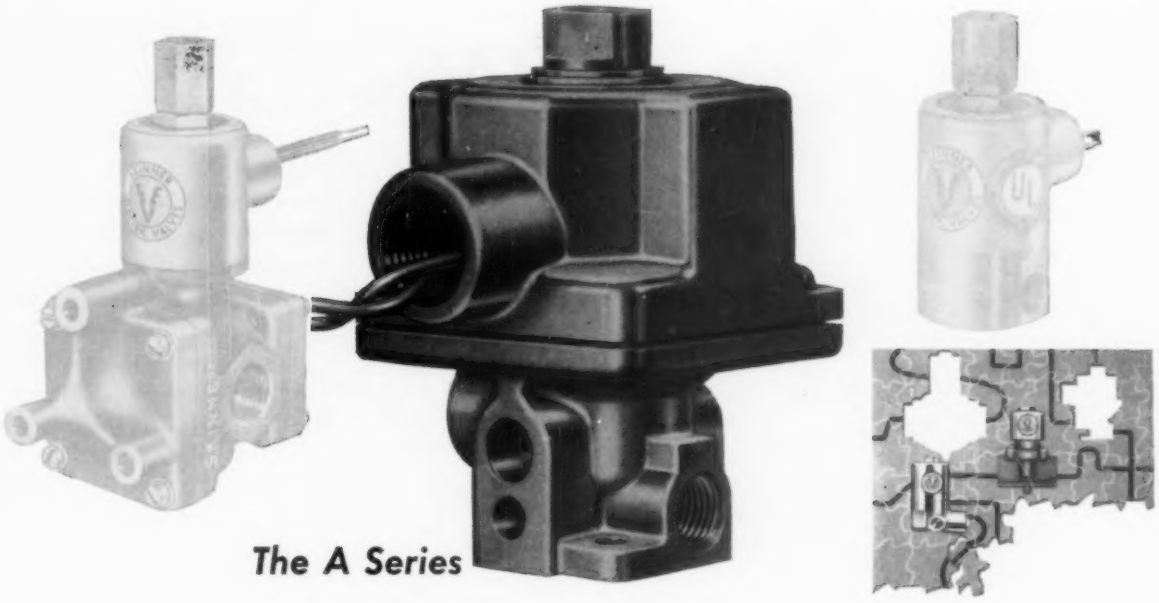
provides ultra-high regulation from 160 to 600 v for loads from zero to 100 ma. It has 0.002% regulation and 100 microv ripple over entire operating range, 160 to 600 v and 0 to 100 ma. For line voltages between 105 and 125 v, full rated current can be drawn continuously with a substantial margin of safety. Internal impedance is less than 0.1 ohm for frequencies to 100 kc. Typical 10-hr drift is 500 ppm. In addition to the dc output, two independent 6.3-v ac outputs are each rated 5 amp. Instrument is 7½ x 10 x 15 in. deep, for bench use. Available for relay rack mounting. Price is $295, FOB plant. **Krohn-Hite Corp., 580 Massachusetts Ave., Cambridge 39, Mass.**

Circle 27, inside back cover

Oscillograph chart viewer . . .

has variable chart-drive speeds from 15 in./min to 100 ft/min and accepts charts to 16 in. wide and 200 ft long. Designed especially for use with 1- to 8-channel regular or translucent charts. Viewer has a direction-reversing switch combined with speed control to allow rewinding. Automatic braking prevents supply roll overrun when speed is reduced. Plastic cursor slides left to right and is pivoted at one end to allow rotation through a small angle. Over-all dimensions are 36 x 22½ x 7¼ in. high. Total weight is about 25 lb. **Sanborn Co., 175 Wyman St., Waltham 54, Mass.**

Circle 28, inside back cover



The A Series

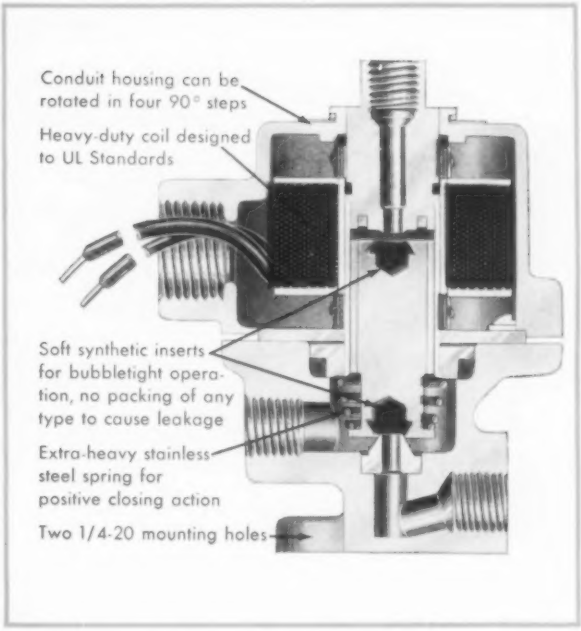
NEW— three-way Skinner Valve line for medium-size cylinders

This new A Series valve line bridges the gap between the famous V5 line used with small cylinders and the reliable M3 line used with large cylinders. The design of this new line permits economical and efficient operation of medium-size cylinders as well as faster operation of smaller cylinders where increased cycling speed is a necessity.

The first of the A Series line is a 3-way normally closed valve with a $\frac{5}{32}$" orifice and $\frac{1}{4}$" NPT ports, and a pressure rating of 125 PSI. It is designed for use with such media as oil, air and inert gases.

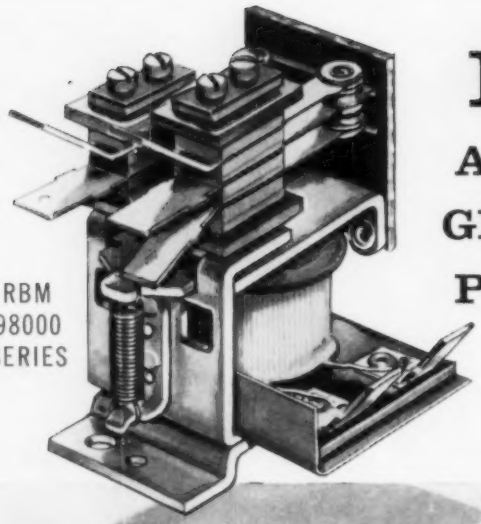
Despite the increase in capacity, this new valve is light in weight (only 3 pounds) and compact ($3\frac{7}{8}$" high and $2\frac{5}{8}$" square). The body and mounting are non-corrosive zinc and the internal parts are stainless steel. The plunger is spring-loaded and direct-acting, and the valve can be mounted in any position. Soft synthetic inserts are used, assuring bubbletight operation and long, trouble-free life.

For additional information, options and specifications, call the Skinner Representative or Distributor nearest you – he's listed in the Yellow Pages. Or write us at the address below, Dept. 457.


Conduit housing can be rotated in four 90° steps
Heavy-duty coil designed to UL Standards
Soft synthetic inserts for bubbletight operation, no packing of any type to cause leakage
Extra-heavy stainless steel spring for positive closing action
Two 1/4-20 mounting holes

SKINNER ELECTRIC VALVES
THE CREST OF QUALITY

SKINNER ELECTRIC VALVE DIVISION
NEW BRITAIN CONNECTICUT
105 EDGEWOOD AVENUE



RBM 98000 SERIES

RBM

AC OR DC GENERAL PURPOSE RELAY

Since the basic relay and its many contact forms, ratings, and terminal variations are regular production items at RBM, design bottlenecks can be shattered. RBM has "CUSTOMER-ized" these relays to fulfill almost every conceivable requirement. This vast background of application engineering can serve you with design shortcuts . . . lower your "finished product" cost. Ask your RBM product application engineer.

RBM'S VERSATILITY PERMITS ENGINEERING SHORT-CUTS THAT LOWER YOUR "FINISHED PRODUCT" COST!

MANY ARE LISTED BY U/L FILE NOS. E12139 OR E22381

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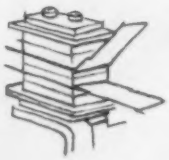

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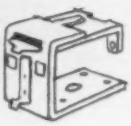
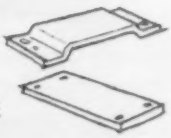
SIMPLIFIED MAGNET FRAME AND ARMATURE ASSEMBLY PROVIDES EFFICIENT, POSITIVE ACTION

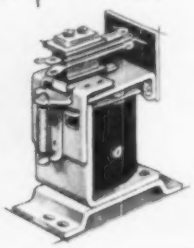


VARIETY OF MOUNTINGS AVAILABLE



OTHER FEATURES	A.C. 98700 TYPE	D.C. 98600 TYPE
• MAX. COIL VOLTAGE	230AC	115 DC
• MAX. COIL RES. IN OHMS	—	20000
• MAX. COIL WATTS OR VOLT AMPS.	9.0 V.A. INRUSH 6.5 V.A. SEALED	4.0 W.
• MAX. CONTACT FORM WITH RATED CURRENT AT 32 V. DC OR 115 V. AC (NON-INDUCTIVE LOAD)	2PDT 15 AMPS. 4PDT 6 AMPS. 6PDT 3 AMPS	2PDT 15AMPS. 4PDT 6AMPS. 6PDT 3AMPS.
• APPROX. WEIGHT	4.1 OZ.	4.1 OZ.

ALSO AVAILABLE IN 97000 SERIES PROVIDING ADDITIONAL COIL POWER... GREATER SENSITIVITY



Consult Your Local RBM Product Application Engineer or Write For Bulletin 1060

RBM Division

ESSEX WIRE CORPORATION, LOGANSPORT, INDIANA

CATALOGS and BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover.

PERFORATED MATERIALS—Catalog 75, 156 pp. Tab-indexed information on ordering, fabrication, and application of perforated materials. Over 30 pages are devoted to illustrating how perforated materials are used. Tables include data such as areas of squares and circles, circumferences of circles, gages and weights, weight conversion, millimeter equivalents of inches, percentage of open area. Harrington & King Perforating Co., Inc., 5655 Fillmore St., Chicago 44.

Circle 29, inside back cover

CAST STAINLESS STEEL—Technical folder, 4 pp. Lists 29 heat and corrosion-resistant alloys available for castings and its line of valves and fittings. Contains a cross-reference chart of ACI, AISI, SAE and ASTM designations. Data on each of the alloys has been expanded to include nominal analyses and typical mechanical properties at room temperature. Heat treatment data is included. Cooper Alloy Corp., Hillside, N. J.

Circle 30, inside back cover

STAINLESS STEEL PRICES — Folder holds price lists for wire, bars and billets, sheet, strip. Lists a schedule of quantity surcharges. Chase Brass & Copper Co., Waterbury 20, Conn.

Circle 31, inside back cover

METALLIC SEALING RINGS — Brochure, 8 pp. Discusses performance and application of sealing rings. Included are illustrations and definitions of four major types, materials, and a 4-page specification table. Koppers Co., Inc., Metal Products Div., 200 Scott St., Baltimore.

Circle 32, inside back cover

DUCTILE IRON PIPE FITTINGS — Catalog 2-PF, 8 pp. Includes types and sizes, typical applications, prices, safety factors and service ratings. Also, comparative physical properties of various pipe fitting metals. Explains production control tests and data on impact testing. Kuhns Brothers Co., 1800 McCall St., Dayton, Ohio.

Circle 33, inside back cover

LOGARITHMIC MEAN TEMPERATURES—Chart, 2 pp. Gives initial temperature difference, final temperature difference and logarithmic mean temperature difference. Dean Products, Inc., 616 Franklin Ave., Brooklyn 38, N. Y.

Circle 34, inside back cover

PHILLIPS CROSS RECESSED HEAD SCREWS—Reference book, about 36 pp. Gives information on all standard units, including dimensions, sizes and dimensional drawings. Screw Research Association Office, 1015 Chestnut St., Philadelphia 7.

Circle 35, inside back cover

BATTERIES—Technical bulletin, 4 pp. Describes a new activating method that allows primary batteries to be activated and operated in any position. With cross-section drawings. Yardney Electric Corp., 40-50 Leonard St., New York 13.

Circle 36, inside back cover

MASTER SWITCH CONTROLS—Bulletin 5701A, 8 pp. Presents design features and engineering data. Contains voltage ratings, contact arrangements and action, outline diagrams, list prices and ordering information. Furnas Electric Co., 1050 McKee St., Batavia, Ill.

Circle 37, inside back cover

ELECTRICAL CONTACTS—Folder 501, 4 pp. Describes and illustrates projection-welded contacts. Discusses forms, materials, applications, advantages, properties, methods of attachment and projection-welded assembly service. Gibson Electric Co., Box 634, Delmont, Penna.

Circle 38, inside back cover

MECHANICAL STEEL TUBING—Bulletin RCP-960, 8 pp. Specification charts give sizes, wall thicknesses, approximate weights, standard mandrel bends and standard 90° bends without mandrels. Uses and advantages of resistance-welded round steel tubing are described. Step-by-step production is shown. Rome Cable Corp., Publications Div., Rome, N. Y.

Circle 39, inside back cover

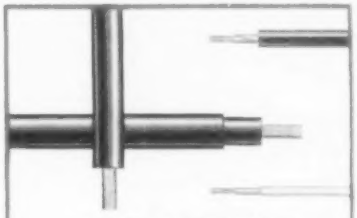
ALTITUDE PRESSURES — Wallet-size table. Gives equivalent pressures in millimeters of mercury for the range of altitudes from sea level to 2,000,000 ft. Vacuum Equipment Div., F. J. Stokes Corp., 5500 Tabor Rd., Philadelphia 20.

Circle 40, inside back cover

TEFLON AND KEL-F PRODUCTS—Catalog, 32 pp. Covers chemical, electrical and mechanical properties. Describes and provides specifications on products made from Teflon and Kel-F. Also, data and illustrations on line of mechanical

(Continued on page 100)

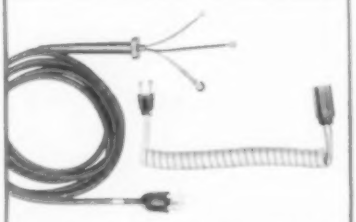
They can be *your* design assistants on other Essex Engineered Products.



WIRE AND CABLE

A complete line of appliance wiring material, radio, television and electronic hook-up wire, 200° C high temperature Sil-X wire, automotive wires and cables, and flexible cords.

Wire and Cable Div., Ft. Wayne, Ind.



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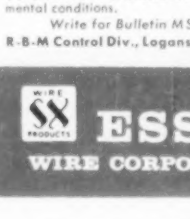
Cords Limited Division, DeKalb, Ill.



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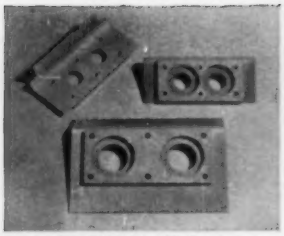
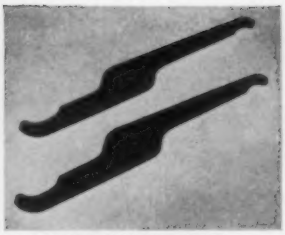
R-B-M Control Div., Logansport, Ind.

ESSEX WIRE CORPORATION

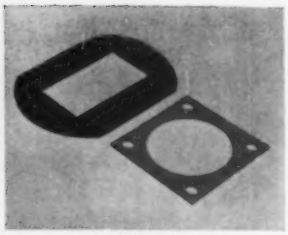


BAFFLE PLATES

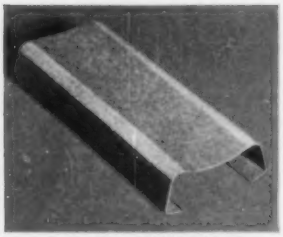


FUSE-PULLER PARTS

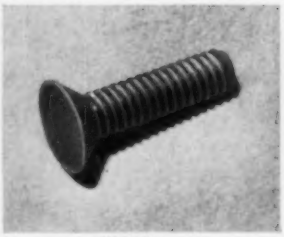
DISCS



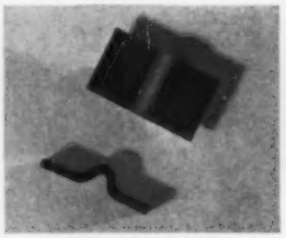
GASKETS



FORMED INSULATOR



SCREW



FORMED CLAMPS

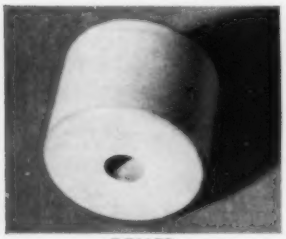
INSULATING BUSHING

SPOOL

CABLE GRIP

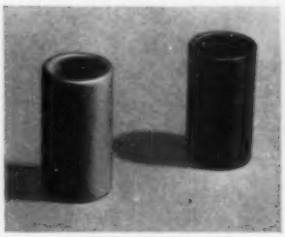
BUSHING

FORMED INSULATORS

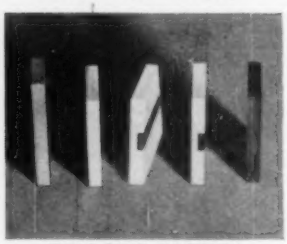


ROLLER

NUMBER TAG



BINDER BUSHINGS



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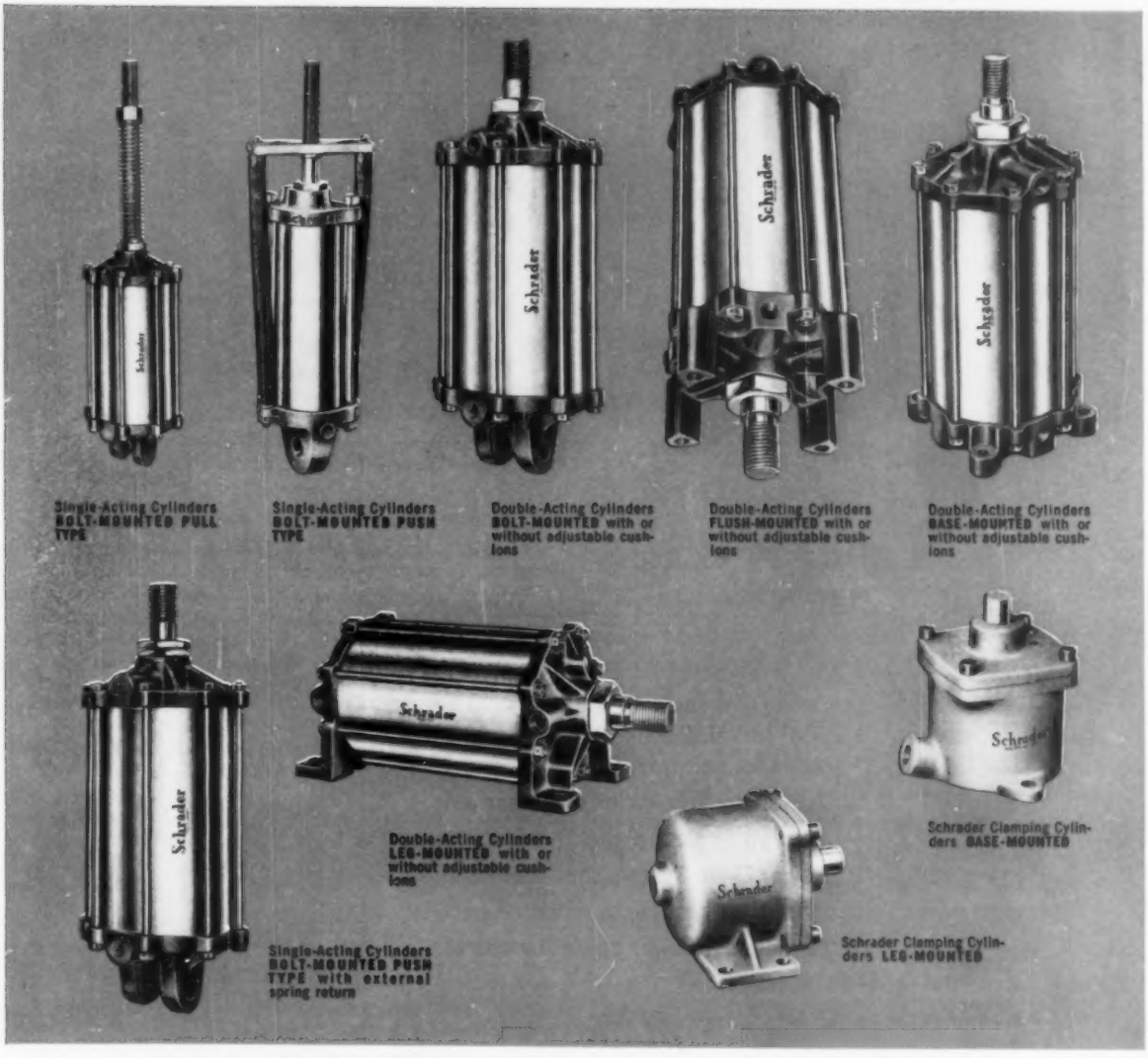
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Double-Acting Cylinders BASE-MOUNTED with or without adjustable cushions
Double-Acting Cylinders LEG-MOUNTED with or without adjustable cushions
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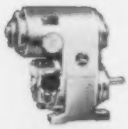

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Catalogs and Bulletins . . . . . continued

packings, gaskets, expansion joints and flexible couplings, custom-machined parts, wire braid and rubber-covered hose, tubing, O-rings, bearings and coating. Plastic Products Div., Raybestos, Inc., Manheim, Penna.

Circle 41, inside back cover

LOW CARBON GROUND FLAT STOCK—Bulletin 1110, 4 pp. Describes the free machining stock and lists sizes available. Gives suggestions for use, specifications and heat treatment. L. S. Starrett Co., Athol, Mass.

Circle 42, inside back cover

CUSTOM FASTENINGS—Brochure, 12 pp. Illustrates 123 fastenings for industrial use. Victor Products Corp., 2635 W. Belmont Ave., Chicago 18.

Circle 43, inside back cover

STAINLESS MECHANICAL TUBING—Bulletin TB 365-A, 8 pp. Explains selection of the proper type of mechanical tubing. Also, industry tolerance tables covering diameter, ovality, wall thickness, straightness, length and machining allowances for both seamless and welded varieties. Babcock & Wilcox, Beaver Falls, Penna.

Circle 44, inside back cover

FASTENERS—Brochure, 12 pp. Guide to the design and specification of cold- and hot-headed parts. Discusses volume, lengths, tolerances, extrusion, pointing, fillets, threading, knurling, material selection and specification information. Buffalo Bolt Co., North Tonawanda, N. Y.

Circle 45, inside back cover

AIR AND LOW-PRESSURE HYDRAULIC CYLINDERS—Bulletin 25, 36 pp. General information on cylinders is followed by specific data on dimensions. Installation and operation suggestions are given. Pathon Mfg. Co., Cincinnati 12.

Circle 46, inside back cover

FHP MOTORS—Catalog, 9 pp. Revised booklet contains illustrations and specifications of eight basic ac motors. General Industries Co., Elyria, Ohio.

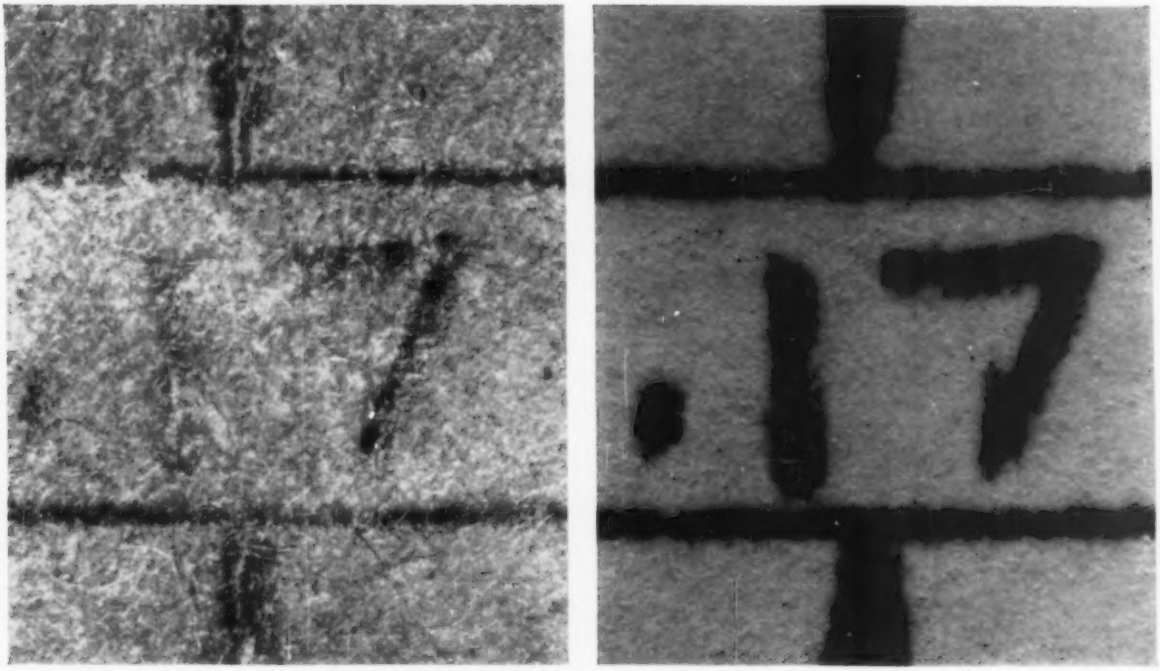
Circle 47, inside back cover

HYDRAULIC PUMPS AND FLUID MOTORS—Catalog 111, 4 pp. Describes pumps and motors and give construction, performance curves, data on pump-motor combinations, duplex or tandem models and geared flow dividers. Dept. PR, Tuthill Pump Co., 963 E. 95th St., Chicago 19.

Circle 48, inside back cover

CARTRIDGE AND CERAMIC HEATING UNITS—Catalog, 12 pp. Gives wattage calculation data, basic values for heat equations, construction, operation, dimen-

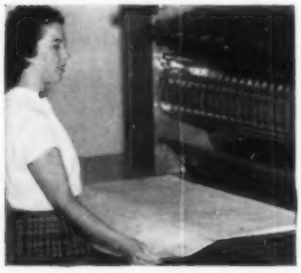
(Continued on page 104)



These photomicrographs show effects of identical handling on (l.) a pencil drawing and (r.) an Autopositive Paper intermediate made from same drawing

Don't let your drawings smudge away!

JUST FILING a pencil drawing—and pulling it out of the files—will in time mess up your sharpest creation. *Make prints* from the drawing . . . use it for reference, and you speed the need for retracing, increase the possibility of reading errors.



It just doesn't make sense to watch your costly tracings smudge away when you can protect them for pennies per sq. ft.

Have your print room, or local blueprinter, make Kodagraph Autopositive Paper intermediates from your tracings. Put these Autopositives in your active drawing file—use them for reference in the drafting room and for all printmaking. Their dense black photographic line detail—on a white translucent paper base—will remain intact even after being used hundreds of times.

Autopositive Paper gives you positive intermediates directly. No special equipment or darkroom needed.

EASTMAN KODAK COMPANY
Graphic Reproduction Division, Rochester 4, N. Y.

Kodagraph Reproduction Materials

New booklet is jam-packed with valuable tips on saving drafting time, protecting drawings, getting better prints.

MAIL COUPON FOR FREE BOOKLET

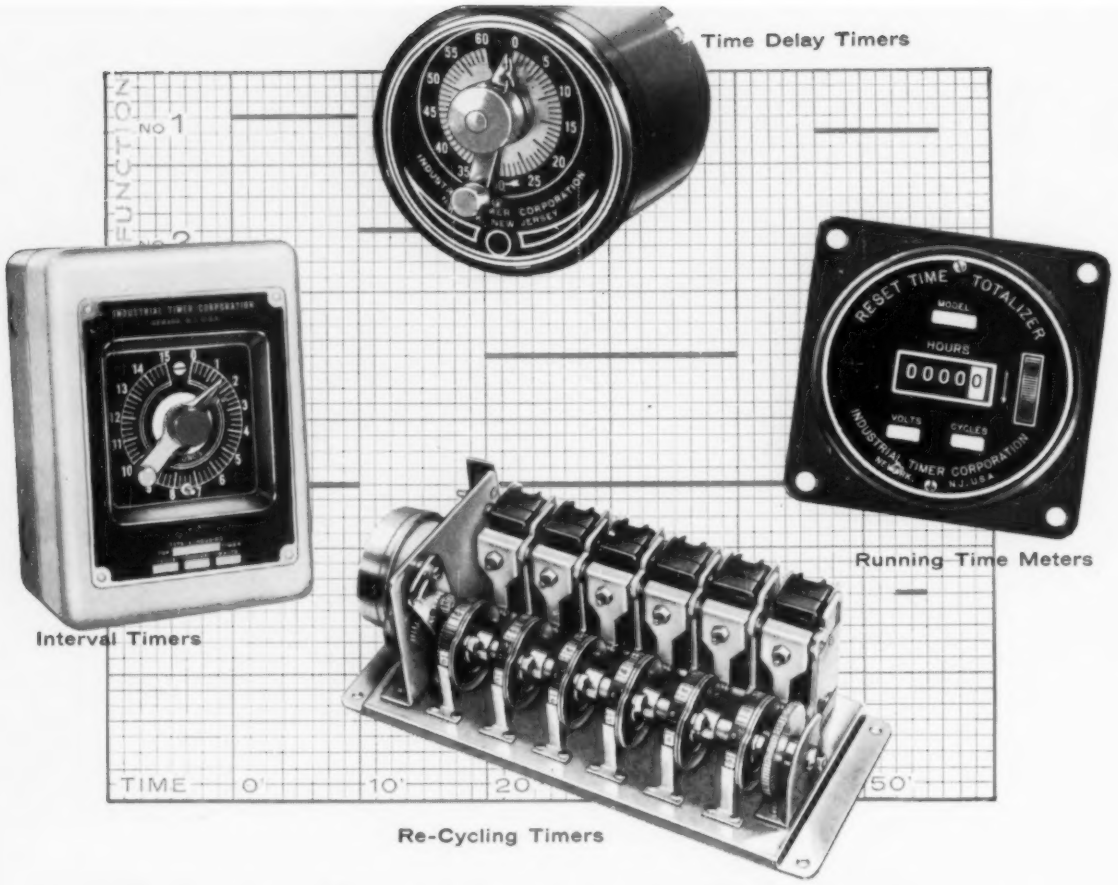
EASTMAN KODAK COMPANY
Graphic Reproduction Division, Rochester 4, N. Y. 15-7
Gentlemen: Send me a free copy of your new booklet on Kodagraph Reproduction Materials.

Name_____ Position_____

Company_____ Street_____

City_____ Zone____ State_____

Kodak TRADE MARK



Timers for Automatic Control ...Standard or Special?

You'll get quick deliveries from Industrial Timer

If slow deliveries of timers have been delaying you in your automatic control projects, try us! True, your problem may be different and difficult indeed, for no two automatic control jobs are exactly alike. But our record in helping out in situations like these is excellent. For in this field we have a valuable background, twenty years of timer experience to be exact, that has provided us with the special knowledge required to supply our customers with the right answers.

How do we do it? The answer is in what we believe to be the largest variety of standard and combination timer units anywhere in the industry. To fill the widely varying needs of our customers, we manufacture a complete line of timers in the four broad classifications illustrated above: Time Delay Timers, Re-Cycling Timers, Interval Timers, and Running Time Meters. From these our timer engineers have developed 20 basic types which they have so far combined in over 1000 different ways. Therefore—many jobs that would seem to require a special timer, are in fact, a standard timer with us.

And our large stock assures you of rapid deliveries—even when we have to create a brand new timer for your special needs. So why not send us your specifications. You'll get a prompt reply and you may save yourself much lost motion.

Timers that Control the Pulse-Beat of Industry

INDUSTRIAL TIMER CORPORATION

1415 McCARTER HIGHWAY, NEWARK 4, N. J.

AFFILIATE—LINE ELECTRIC COMPANY

Catalogs and Bulletins.....continued

2 Giant Waldes Truarc Beveled Rings Cut Costs $500, Save 76½ Hours Machining-Assembly Time on X-Ray Unit

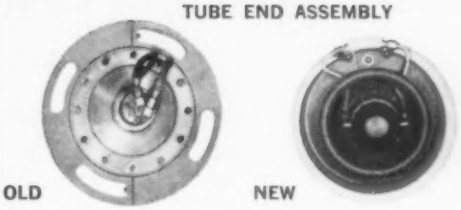
TRIPLETT & BARTON TRI-IND-X PORTABLE X-RAY UNIT

OLD MODEL NEW MODEL

	OLD SPECIFICATIONS	NEW SPECIFICATIONS
Weight	107 lbs.	65 lbs.
Diameter	15 inches	11 inches
Machining and Assembly Time	78 hours	1½ hours
Service Time	4½ hours	5 minutes
Parts	27 bolts	2 Truarc Rings

Prior to adoption in their new bantam-weight TRI-IND-X, Triplett & Barton, Inc., Burbank, Calif., subjected Waldes Truarc Retaining Rings to severe tests and rigid inspections. Although the TRI-IND-X operates at a normal pressure of 50 psi, Truarc Rings were subjected to pressure tests in excess of 500 psi, proving their high performance.

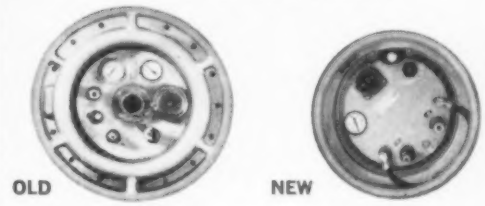
TUBE END ASSEMBLY



OLD NEW

ONE 10" BEVELED RING REPLACES 12 BOLTS—Machining and assembly time formerly required 78 hours . . . now reduced to 1½ hours! Service operations for dismantling or tube change formerly required 4½ hours . . . now reduced to 5 minutes! In addition to savings on materials, costs have been reduced approximately $500 per unit.

END BELL ASSEMBLY



OLD NEW

ONE 9" BEVELED RING REPLACES 15 BOLTS—In addition to functioning as mechanical fasteners, the Truarc Beveled rings serve as pressure vessel closures, providing leak-proof seals. The wedge action of the ring compensates for wear, provides a constant tight seal.

Whatever you make, there's a Waldes Truarc Ring designed to save you material, machining and labor costs, and to improve the functioning of your product.

In Truarc, you get

Statistically Controlled Quality from engineering and raw materials to the finished product. Every step in manufacture watched and checked in Waldes' own modern plant.

Complete Selection: 36 functionally different types. As many as 97 standard sizes within a ring type. 5 metal specifications and 14 different finishes. All types available quickly from leading OEM distributors in 90 stocking points throughout the U. S. and Canada.

Field Engineering Service: More than 30 engineering-minded factory representatives and 700 field men are at your call.

Design and Engineering Service not only helps you select the proper type of ring for your purpose, but also helps you use it most efficiently. Send us your blueprints today . . . let our Truarc engineers help you solve design, assembly and production problems . . . without obligation.

WALDES

TRUARC®

RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, N. Y.

Waldes Kohinoor, Inc., 47-16 Austel Place, L.I.C.1, N.Y.
Please send new, descriptive catalog showing all types of Truarc rings and representative case history applications.
(Please print)

Name_____

Title_____

Company_____

Business Address_____

City_____ Zone____ State_____

PN-070

Consult the Yellow Pages of Your Telephone Directory for Name of Local Truarc Factory Representative and Authorized Distributor. Look under "Retaining Rings" or "Rings, Retaining."

P&B MICRO-MINIATURE RELAYS LEAD IN

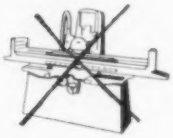
Have you seen our

BIG NOs?

save time and cost with *Laminum* Shims

NO machining

NO grinding



NO counting

NO stacking

NO miking

and ***NO*** *dirt between layers—ever*

LAMINATED SHIMS OF

And *only in Laminum* are laminated, surface-bonded shims available *in all four materials* as shown below.

LAMINUM®

SURFACE BONDED . . . THEY *peel* FOR ADJUSTMENT

Laminated Shims of **LAMINUM** now available in

STAINLESS STEEL with laminations of .002" or .003"	**LOW CARBON STEEL** with laminations of .002" or .003"
BRASS with laminations of .002" or .003"	**ALUMINUM** with laminations of .003" only

LAMINATED SHIM COMPANY, INC.

Shim headquarters since 1913

1407 Union Street, Glenbrook, Conn.

sions. Also, application data on heat losses. Hotwatt, Inc., 16 Gould St., Danvers, Mass.

Circle 49, inside back cover

IN-LINE DIGITAL INDICATOR—Catalog 51-1800, 11 pp. Describes, gives background, features and operating details. Supplemented with diagrams. Fischer & Porter Co., 627 Jacksonville Rd., Hatboro, Penna.

Circle 50, inside back cover

ELECTRONIC WORK CENTER—Brochure, 6 pp. Describes components and equipment included in packaged electrical-electronic work lab. Gives detailed listing and prices. Alden Products Co., 117 N. Main St., Brockton 64, Mass.

Circle 51, inside back cover

MINIATURE THERMOCOUPLES—Catalog, 28 pp. Describes four basic designs with illustrations, application data, gasket sizes, lead and terminal information. Gives specifications. Thermo Electric Co., Inc., Saddle Brook, N. J.

Circle 52, inside back cover

HOSE ASSEMBLIES—Catalog 402, about 28 pp. Revised catalog of hose assemblies and couplings. Provides general design information, port dimensions for bolted flange connections. Describes dimensions, construction and general characteristics of various units. With dimensional drawings. Anchor Coupling Co., Inc., E. Church & 4th Sts., Libertyville, Ill.

Circle 53, inside back cover

RESIN DATA—Wall chart. Describes casting resins, plastic surface coatings, adhesives, cements and sealants, impregnating resins, and tooling resins. Gives property data, performance data, and applications. Chart may be folded for reference or mounted on wall. Emerson & Cuming, Inc., 869 Washington St., Canton, Mass.

Circle 54, inside back cover

COBALT-BASE ALLOYS—Booklets, 16 pp. each. Describe properties of alloys No. 21 and 31. List chemical composition, physical and mechanical properties of each alloy. Haynes Stellite Co., Div. Union Carbide Corp., 30-20 Thomson Ave., Long Island City 1, N. Y.

Circle 55, inside back cover

CIRCULAR SLIDE RULE—Pocket-size calculator performs simple calculations. Multiplies, divides and proportions. With instructions. Free. General Industrial Co., 5738 N. Elston Ave., Chicago 30.

Circle 56, inside back cover

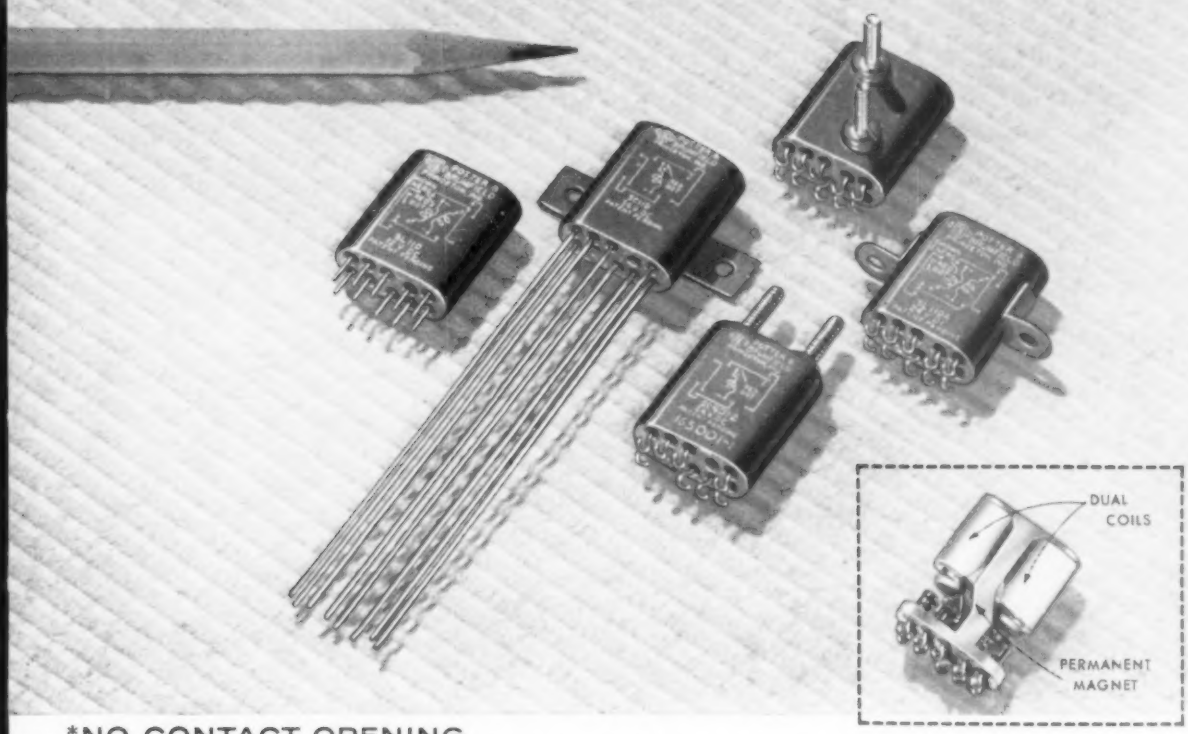
BRONZE POSITIVE DISPLACEMENT PUMPS—Catalog section 109, 4 pp. De-

(Continued on page 106)

P&B MICRO-MINIATURE RELAYS LEAD IN

performance

SHOCK: 100g* VIBRATION: 30g to 2000 cps*

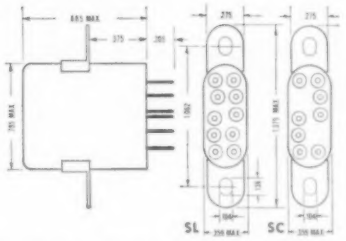


*NO CONTACT OPENING

New P&B crystal-case size relays, the SC and the SL (magnetic latching), show amazing shock and vibration capabilities. They absorb shocks of 100g and vibrations 30g to 2000 cps. without contact openings!

A highly efficient magnetic structure utilizing a permanent magnet makes possible at least twice the contact pressure found in DPDT relays of comparable size. One watt of power for three milliseconds operates either relay. Transfer time is unusually fast —0.5 milliseconds maximum.

For more information, contact your P&B sales engineer, or write Potter & Brumfield, Princeton, Indiana.



SL—dual coil latching relay. Operates on a 1 watt, 3 ms. pulse at nominal voltage. Permanent magnet latch locks the armature in either position.

SC—non-latching relay with series-connected dual coils. Operates on approximately 1 watt at nominal voltage. Coils must remain energized to hold the armature in the operate position.

SC and SL Series Engineering Data

GENERAL:
Insulation Resistance: 10,000 megohms, min.
Breakdown Voltage: 1,000 V. RMS.
Shock: 100g.
Vibration: 30g 55 to 2000 cps., 0.195" max. excursions from 10-55 cps.
Temperature Range: —65° C. to + 125° C.
Weight: 15 grams without mounting bracket.
Operate Time: 3 MS. max. with 550 ohm coil @ 24 V. DC. (SL: 630 ohm coil at 24 V. DC).
Transfer Time: 0.5 MS max.
Terminals: (1) Plug-in for microminiature receptacle of printed circuit board. (2) Hook end solder for 2 #24 AWG wires. (3) 3" flexible leads.
Enclosure: Hermetically sealed.

CONTACTS:
Arrangement: 2 Form C.
Material: Gold flashed palladium.
Load: 2 amps @ 28 V. DC, resistive; 1 amp @ 115 V. 60 cycles AC, resistive.
Pressure: SC—16 grams min.; SL—20 grams min.

COIL:
Power: Approx. 1.0 watt at Nominal Voltage.
Resistance: SL—40 to 1400 ohms; SC—35 to 1250 ohms.
Duty: Continuous.

MOUNTINGS:
Bracket, stud and plug-in.

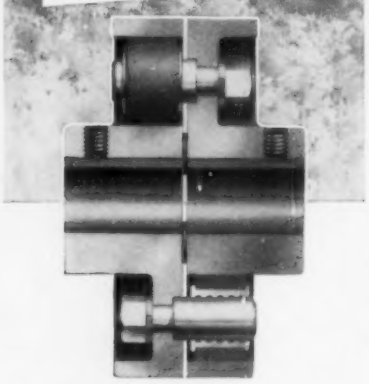
P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR

POTTER & BRUMFIELD INC.

PRINCETON, INDIANA · SUBSIDIARY OF AMERICAN MACHINE & FOUNDRY COMPANY

Rx AJAX

FLEXIBLE COUPLINGS CURE YOUR BREAKDOWNS DUE TO MISALIGNMENT



Usually you don't detect misalignment strains until something lets go. That's why it is good preventive practice to specify Ajax Flexible Couplings on new equipment and also install them on your present direct-connected machines. You save wear on bearings, gears, impellers, armatures, and housings.

A shut down machine can shut down a department, and that can cost a thousand times more than an AJAX Flexible Coupling.

Complete lines of AJAX bronze bushed, rubber-cushioned and Dihedral gear couplings... angular and/or offset capacity up to 7 degrees ... competitive prices.

Write for catalog

AJAX

FLEXIBLE COUPLING CO. INC.

WESTFIELD, N. Y.

Catalogs and Bulletins.....continued

scribes 61 pump models with model selection charts, data on mounting styles, typical pump characteristic curves and tables showing relationship of speed, capacity, pressure and power consumption. Dept. R, Tuthill Pump Co., 963 E. 95th St., Chicago 19.

Circle 57, inside back cover

ACCESS DOOR AND DAMPER HARDWARE—Catalog, 8 pp. Describes line of access door hardware, access doors and damper hardware. With price information. Ventfabrics, Inc., 640 N. Kedzie Ave., Dept. 237, Chicago 12.

Circle 58, inside back cover

MULTISPEED GEAR REDUCER — Bulletin 358, 8 pp. Gives construction, torque capacities, applications, mounting data and reduction ratios for two basic models. Reducer changes ratios without clutching. Haxton Gear Co., 7-11 Main St., East Rockaway, N. Y.

Circle 59, inside back cover

MICROSIZE FASTENERS—Bulletin, 4 pp. Size 0 through 3 socket-head cap screws and set screws with nylon self-locking inserts are described and illustrated. Reviews design and processing features. Specs and ordering information are given. Standard Pressed Steel Co., Box 545, Jenkintown, Penna.

Circle 60, inside back cover

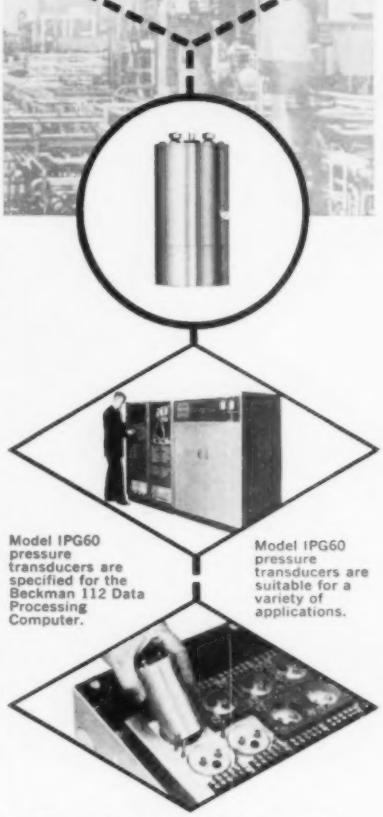
MAGNETIC EQUIPMENT—Booklet, 48 pp. Gives applications of permanent, non-electric magnetism in modern materials handling and magnetic separation equipment. Supplies information on capabilities and possible uses of magnetism. Eriez Mfg. Co., 70D Magnet Dr., Erie, Penna.

Circle 61, inside back cover

"Now in the space where it asks if you drink, erase 'willing to learn' and write 'No'."

IPG60 PRESSURE TRANSDUCERS

THE RELIABLE HEART OF PROCESS CONTROL

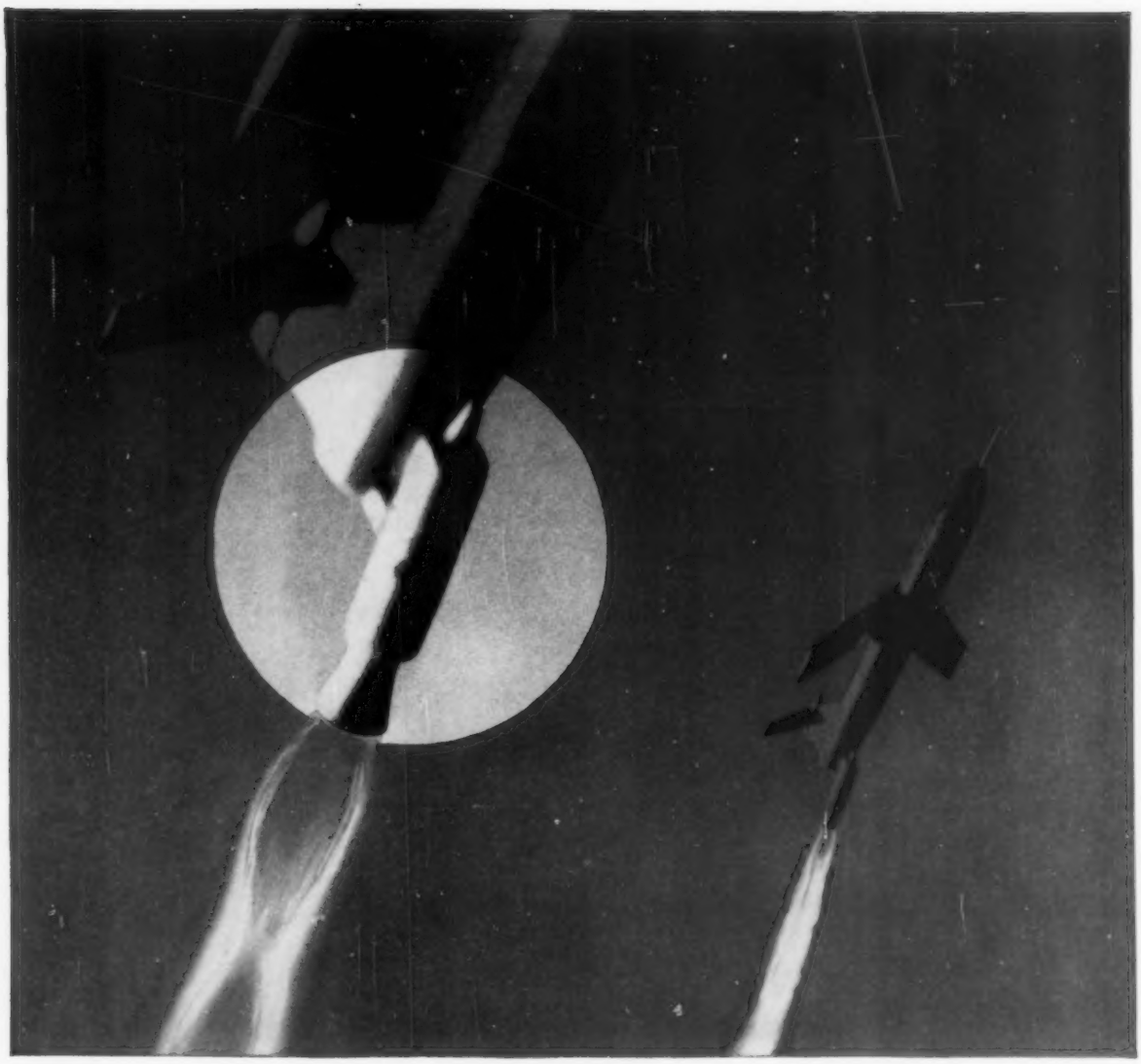

Model IPG60 pressure transducers are specified for the Beckman 112 Data Processing Computer.
Model IPG60 pressure transducers are suitable for a variety of applications.

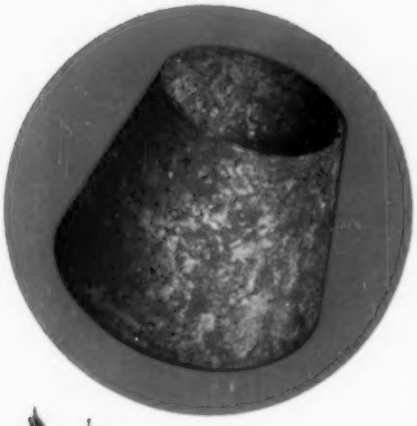
The evolution of industry toward automation has created a demand for precision data handling systems such as the Beckman 112 Data Processing Computer. Statham Model IPG60 pressure transducers are specified in this system, providing basic information signals which are accurate within ±¼%. Complete data on the Model IPG60, or information on other Statham instruments, are available upon request.

RANGE: 0 to +15 psig.
PRESSURE MEDIA: Non-corrosive fluids
OUTPUT: Approximately 35 mv. full scale at 14 V. excitation
NON-LINEARITY & HYSTERESIS: Not more than ±0.25% of full scale

Statham

STATHAM INSTRUMENTS, INC. of Puerto Rico
254 Carpenter Rd., Hato Rey, Puerto Rico
Cable Address: STATRICO
A SUBSIDIARY OF STATHAM INSTRUMENTS, INC
12401 W. Olympic Blvd., Los Angeles, California





ONE-PIECE WELDED CONE FOR THE HOT SPOT

This is the vital nozzle cone of the Martin Mace guided missile. American Welding was able to form it in one piece from ¾-inch plate (FS-1020) and arc weld the joint to produce a tapered cone with a major diameter of 25 inches and a minor diameter of 15 inches. After heat treating and X-ray testing, it proved to be better and more economical than nozzle cones produced by the previous method of forming in two halves.
If you require a circular product and it's metal — call American Welding first.

New Products Catalog. Write today for 20-page catalog of circular products which American Welding can form, weld and machine for you.

THE AMERICAN WELDING & MFG. CO
140 Dietz Road • Warren, Ohio

AMERICAN WELDING

PARKER-KALON DIVISION, *General American Transportation Corporation, Clifton, New Jersey*

PARKER-KALON® "Hi-thred" Self-tapping Screws

For the first time in fastener history—Parker-Kalon introduces Self-tapping screws **THREADED FULL TO THE HEAD . . . THE LAST THREAD ACTUALLY TERMINATING IN AN ANNULAR ORIFICE IN THE HEAD ITSELF** . . . the new P-K *"Hi-thred"* fastener!

It's a completely new idea in fasteners—a screw that reduces annoying and costly slow-downs—holds securely *without spinning or slipping*—even in very thin gage metal sheets.

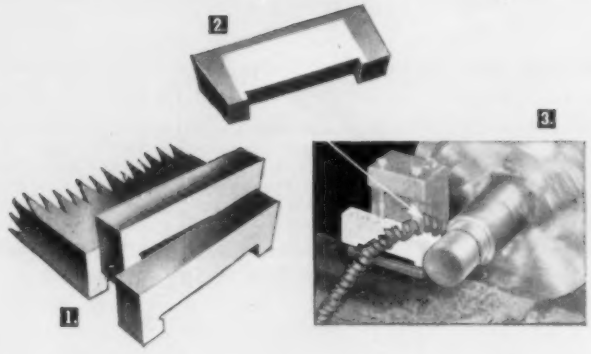
Compare the new P-K® "Hi-thred" with any conventional fastener. See for yourself the incomplete last thread on ordinary screws. Then see how the revolutionary P-K "Hi-thred" is constructed to give you firm, dependable fastening right to the head of the screw.

You can obtain samples from your nearby Industrial Supply Distributor, or write direct to P-K. "Hi-thred" fasteners are available in Types "A" and "Z" in production quantities in non-countersunk head styles.

Look...it's threaded right into the head!

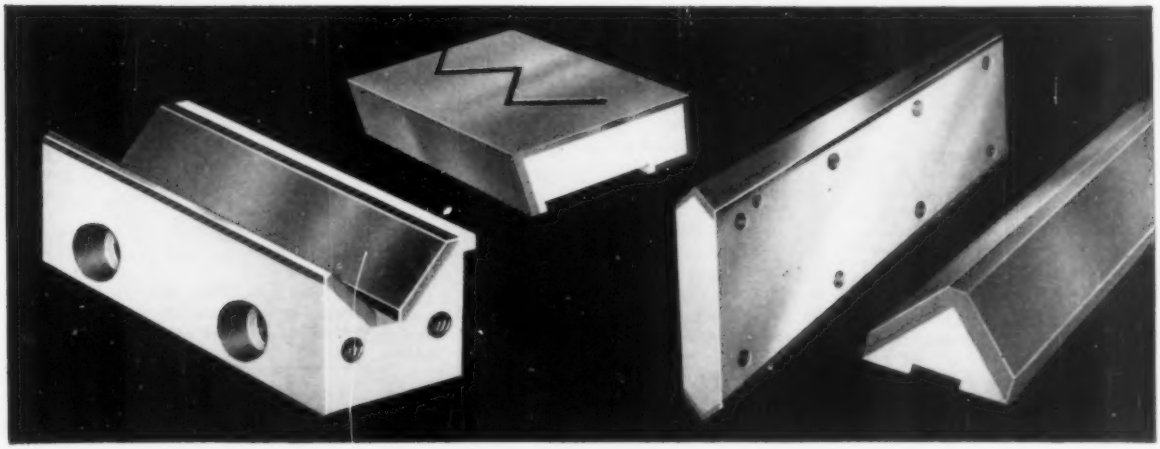
Another new fastener idea from Parker-Kalon

to be sure they're OK



these buyers did... A group of prospective lathe buyers witnessed an amazing demonstration of OK Bedway hardness at the Gisholt Machine Co., Madison, Wisconsin. Gisholt uses OK Ways exclusively on their ram and saddle turret lathes, and to prove the quality they (1) took a section from an OK Bedway, (2) made it into a tool bit, (3) locked it in a fixture and cut spiral shavings from 1045 cold-rolled steel.

look before you buy



here's why: OK Ways are so hard they're practically wear-proof, which helps maintain constant accuracy throughout the life of the machine. In Ohio Knife's exclusive manufacturing process, long-wearing tool steel is welded to a soft steel backing under 2500 tons pressure. Then the ultimate surface hardness of the special-analysis tool steel is developed with a special heat-treating technique that is far superior to simple flame-hardening, carburizing or induction-hardening methods. The result is extreme hardness, 65-66 Rockwell "C", uniform to 3/16" in depth.

For free Ohio Knife bulletin, showing seven standard cross-sections in over 60 sizes, write Dept. 31-5

THE OHIO KNIFE CO.

CINCINNATI 23, OHIO

SLITTER KNIVES • SHEAR BLADES • WORK-REST BLADES
CUT-OFF BLADES • HARDENED SPACERS • HARDENED WAYS
GIBS • BALL RACES • BRONZE WAYS • WEAR STRIPS

GENERAL INDUSTRIES

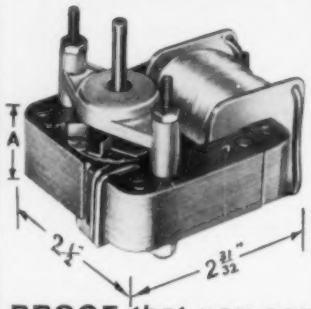
Smooth Power

AC MOTORS

1/1800 H.P. to 1/35 H.P.

MILLIONS

now in use...



PROOF that you can

RELY on GI

Meet an all-around performance champion. GI's husky, versatile Model "A" motor. **Proved dependable millions of times over,** it's the power choice of the nation's great-name manufacturers . . . setting an amazing performance record in countless applications from phonographs to kitchen fans to pumps. If dependability is your aim, Model "A" is your motor!

MODEL "A" two-pole shaded pole motor available in various lamination thicknesses. Precision constructed for reliable, long hard usage. Perfectly balanced for smooth, quiet, operation.

MODEL	HP 2800 RPM	Locked Torque In/Oz	Max. Running Torque In/Oz	Rotor Free Speed RPM	A
A-3-CW A-3-CCW	1/500	0.70	1.1	3360	3/8"
A-5-CW A-5-CCW	1/180	1.7	2.7	3430	5/8"
A-6-CW A-6-CCW	1/130	1.9	3.3	3430	3/4"
A-7-CW A-7-CCW	1/100	2.1	3.8	3500	7/8"
A-8-CW A-8-CCW	1/90	2.5	4.5	3480	1"
A-9-CW A-9-CCW	1/70	2.7	5.3	3520	1 1/8"
A-12-CW A-12-CCW	1/60	3.0	6.5	3500	1 1/2"
A-14-CW A-14-CCW	1/50	3.1	7.0	3490	1 3/4"

Standard shaft diameter .1817, 1/4" shaft available if desired.

Write today for catalog sheet and quantity-price quotations.

THE GENERAL INDUSTRIES CO.

DEPARTMENT GK • ELYRIA, OHIO

DESIGN ABSTRACTS

Papers from the ASLE* 1958 Annual Meeting, Cleveland

Lubrication of High Speed Gears

Excessive amounts of lubricating oil must be avoided. Kinetic energy of oil leaving gears can be used to scavenge it. A veteran engineer is quoted in the paper as saying, "If you've got gears going really fast, they just want to smell the oil." The author states, "I don't believe this paper could be more precisely summarized."

Abstracted from "Some Lubrication Problems in High Speed Gears," J. Dern, Steel Products Engineering Co., ASLE Paper 58AM 6B2.

High-temperature Gear Operations

Running tests to determine oxidation stability, thermal stability and wear tests indicate most promising lubricants are 81644 silicone, Dow Corning DCXF258, Socony XRM326 mineral oil. Tests of gear materials included fatigue life, hot hardness, impact resistance; Halcomb 218 and Nitralloy "N" gave good results.

Abstracted from "Investigation of Factors Affecting High Temperature Gear Operation," E. E. Shipley, General Electric Co., ASLE paper 58AM 5B-2.

Effects of Hydraulic Fluids on Mechanical Packing Materials

Fluids were classified in three groups and packings in five. Combinations of these are discussed. General recommendations for selection of packing materials are included.

Abstracted from "Effects of Hydraulic Fluids on Mechanical Packing Materials," L. R. Tharp, E. F. Houghton & Co., ASLE paper 58AM 6C-3.

High-speed, High-temperature Thrust Ball Bearings

Ball-spin in thrust bearings may raise temperature by friction as much as 100 F above ambient. Since wear, scoring, galling and other destructive phenomena tend to increase with temperature, friction characteristics of a lubricant are important. Principal factors limiting bearing performance are fatigue, deposits, friction. When bearing is oil-air mist lubricated, failure occurs at much lower temperature than with a jet.

Abstracted from "Lubrication of High-speed, High-temperature Thrust Ball Bearings," J. B. Accinelli, S. J. Beaubien and C. S. Reichenbach, Shell Development Co. and MIT, ASLE paper 58AM 2C-1.

Relationship of Lubricant Viscosity and Type to Ball Service Life

Ball life increased with increasing viscosity, varying approximately as the 0.2 power of viscosity. Those lubricants which are least active chemically (silicone and mineral oil) gave better results in tests than the most active (adipate and sebacate), although evidence of chemical action on the test balls was not discernable.

Abstracted from "Effect of Lubricant Viscosity and Type, on Ball Fatigue Life," T. L. Carter and W. J. Cinderson, NACA, ASLE paper 58AM 5A-2.

How Shaft Rotation Affects Bearing Temperature

Recent studies of rotating cylinders were used to predict by the heat balance method oil film temperatures for shaft-and-plain-bearing combinations. Good agreement was obtained between these predicted values and those later established experimentally. It was shown that a shaft, particularly if it is rotating and long enough, can be a major source of heat dissipation.

Abstracted from "Effect of Shaft Rotation on Bearing Temperatures," A. H. Burr, Cornell University, ASLE paper 58AM 4A-2.

"Everybody comfy?"

* For copies of papers, write to ASLE, 84 E. Randolph St., Chicago 1.

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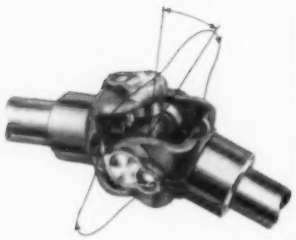

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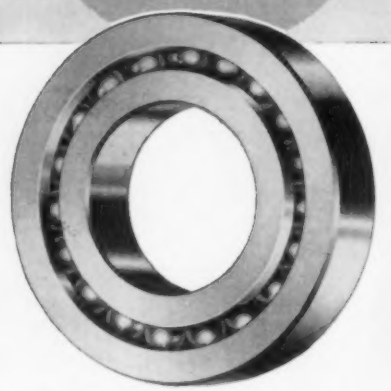

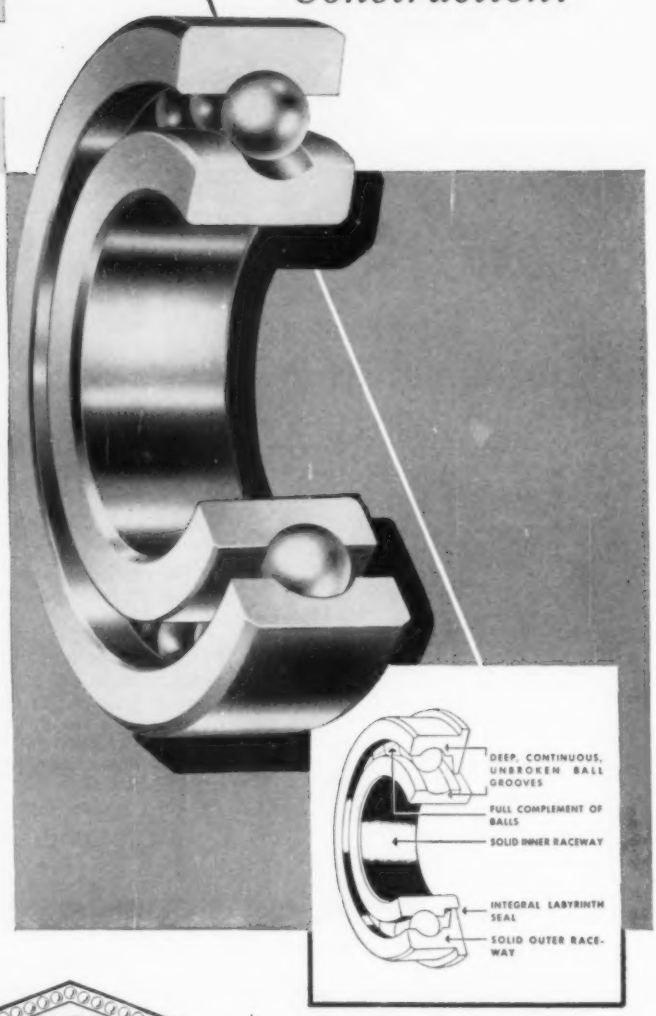

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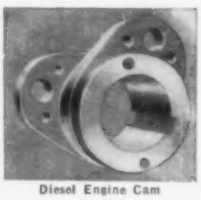

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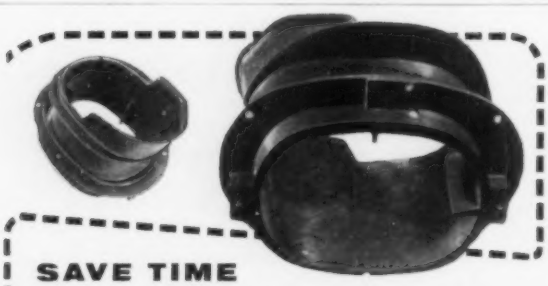

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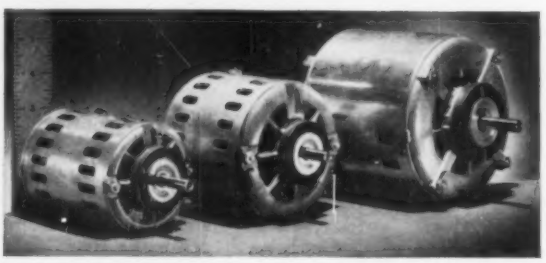

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NEW BOOKS

Fundamental Constants of Physics

E. R. COHEN, K. M. CROWE, J. W. M. DUMOND. *Published by Interscience Publishers, Inc., 250 Fifth Ave., New York 1.* 6¼x9¼, 287 pp, $7.50.

This book surveys the fundamental constants and conversion factors of the physical sciences. It also describes the experiments from which this knowledge is drawn. Contents include: introduction, arbitrarily defined physical units and standards, classical measured constants and units, masses of atoms and mesons, history of the atomic constants, postwar high-precision measurements, and the method of least squares.

Mechanics of Machinery

C. W. HAM, E. J. CRANE, W. L. ROGERS. *Published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36.* 6¼x9¼, 509 pp, $8.50.

This fourth edition of a popular text is designed for a two-course sequence: Mechanism (Part I) and Kinematics and Dynamics of Machinery (Part II). New examples and applications of current interest have been added throughout. ASA symbols and terminology have been adopted and used where applicable. Contents include: linkages and flexible connectors, cams, gear types and manufacturing methods, mechanisms, velocities and accelerations in machines, static and inertia forces, balancing, vibrations and critical speeds, and gyroscopic forces.

Queues, Inventories and Maintenance

PHILIP M. MORSE. *Published by John Wiley & Sons, Inc., 440 4th Ave., New York 16.* 6x9, 202 pp, $6.50.

Book treats general queuing problems, discusses the effect of changes of arrival and service distributions on queuing results, and describes the application of queuing theory to mainte-

(Continued on page 117)

MICRO-BEARING ABSTRACTS

by **A. N. DANIELS**, *President*
New Hampshire Ball Bearings, Inc.

MINIATURE BEARINGS AND GEAR DIFFERENTIAL BACKLASH

(NOTE: We are grateful to W. J. Opocensky, Staff Engineer, Librascope, Inc., Glendale, California, for his factual report on the part played by our bearings in the design of the small two-pinion differential illustrated below.)

LIBRASCOPE 3/16" HOLLOW SHAFT DIFFERENTIAL uses special duplex MICRO-BEARINGS in all gears. Specifications are: Working circle 1.090", Length .980"; input gear hole size .687", Starting torque .2 in. oz. — Maximum backlash 5 min. at 2 in. oz.

Miniaturization of precision ball bearings and gears is well advanced. However, putting them together to produce a small differential with low torque and backlash of five minutes or less is no simple task. Loads on single pinion differentials and on single ball bearings introduce objectionable flexibility. So does uncontrolled radial play in ball bearings whether used singly or in pairs.

After considering many designs, Librascope selected a two-pinion differential as the most logical type to develop. A "hunting tooth" gear ratio was also chosen to distribute wear evenly. Double bearings preloaded were to be used in all gears.

Special miniature bearings were developed to give duplex bearing performance at a cost only slightly higher than regular catalog prices.

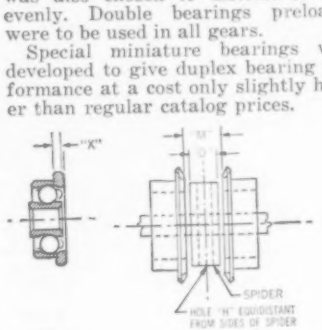

FIG. 1 FIG. 2

Dimension "X" in *Fig. 1* is coded in increments of .0002" under given axial load.

In *Fig. 2* the mounting distance "M" of the bevel gears is known. With the new bearing dimension "X" it is possible to determine the "spider" dimension "D". This provides the desirable mounting distance of bevel gears without shims.

To obtain maximum distance between raceways in limited space, narrow unshielded bearings were selected. To provide dust protection for the bearing a thin shim slightly smaller than the I. D. of the outer bearing race is used between bearing and Truarc ring. Truarcs are stainless steel double-disc-ground to various specific dimensions. With all dimensions controlled, bevel gears are accurately located from the pinion shaft hole, and any desired preload in the bearing can be obtained by selecting a Truarc of proper thickness.

Control of radial play of bearings in pinions presented a different, though similar, problem. Space limitations in the pinion are much more severe than with bevel gears. *Fig. 3* shows how Librascope solved the problem. Dimension "X" is coded in increments of .0001" with a given axial load, from inner race to outer race opposite the flange side on the one hand and opposite the ball retainer side on the other. A precision shim is used between outer races of the two bearings. By selection and use of new coded dimensions, any desired preload of bearings is obtained by fitting bearings to the shim.

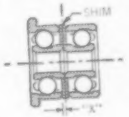

FIG. 3

To keep bearing races in mutual contact, another novel idea is used. Each pinion has its own adjustable shaft. The outside end of the pinion shaft is fitted with a Truarc. This rests against inner race of outside bearing. To overcome the limited adjustment of shims and expensive labor costs, a unique adjustable washer is used. By means of a special tool, each pinion may be adjusted for any desired amount of backlash. Bearings are held at preload by adjustable washer and Truarc. A clamping means secures pinion shaft to "spider".

The Librascope differential design makes possible "5 minute" differentials at 2 in. oz. loads. Measurements are taken at *eight* equally spaced positions for one full turn of the "spider". The maximum backlash recorded determines classification of differential.

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in exactly two minutes...

and the **Chef** is a

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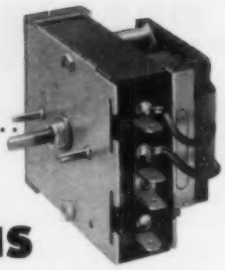

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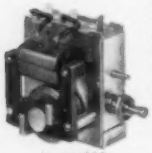

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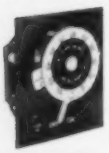

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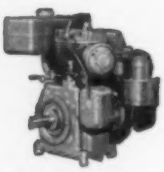

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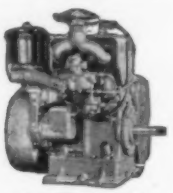
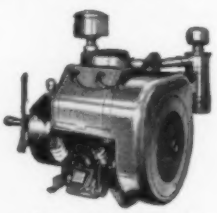


• 2-cylinder, 10 to 18 hp.



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Proceedings of an Electronic Industries Assn. symposium held in Los Angeles last December; covers both ground and airborne devices, but places heavy emphasis on military requirements. Sections on accessibility, environment, and field conditions contain generally applicable design pointers.

ASME Metals Handbook—Processes

ROGER W. BOLZ, *Editor, published by McGraw-Hill Book Co., 330 W. 42 St., New York 36, 448 pp., 7¼ x 9⅞, $13.50.*

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(Continued on page 119)

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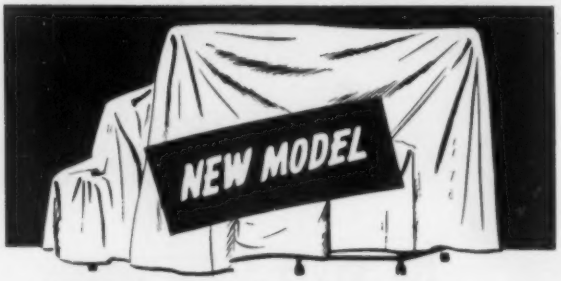

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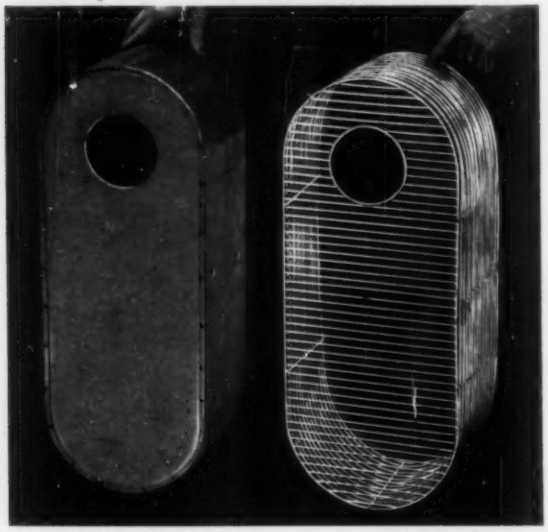

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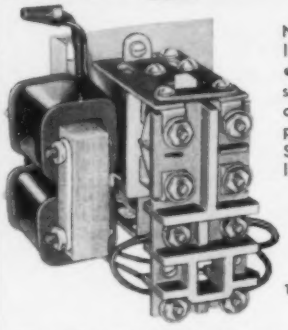

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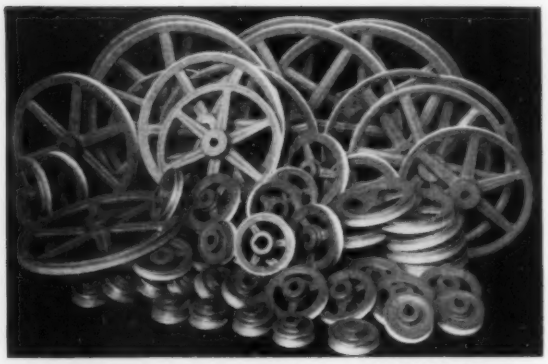

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Machine Pins Standard

Standard ASA B5.20-1958, Published by ASME, 29 W. 39th St., New York 18. 8½ x 11, 15 pp, $1.50.

All types of machine pins are included in this new standard—dowel, straight, taper, clevis, grooved, and cotter pins. This standard supersedes previous standard issued in 1954 and includes following revisions: changes in chamber and tolerance on straight pins and dowel pins; lengths and tolerances added to clevis pins; chisel point added to cotter pin end styles; and grooved pin tables added.

Electronic Industries Fact Book

Available from Electronic Industries Assn., 1721 DeSales St., N.W., Washington 6, D. C., 5½ x 8½ in., paperbound, 28 pp, $0.50.

Proudly noting that it is now the "fifth largest US manufacturing group," the Electronic Industries Assn., presents its latest *Fact Book*. In this 1958 edition are tables of military expenditures for electronics (by types of application); retail sales of radio, TV, and phonograph sets; industrial sales; and utilization of components.

Survey of Heat Transfer Literature

Government Bulletin No. PB 131305. Published by Dept. of Commerce, Office of Technical Services, Washington 25, D. C. 8½ x 11, 50 pp, $1.50.

This report is reprint of original document written by Milton Levy under Government-sponsored research. It is the result of a literature search

(Continued on page 121)

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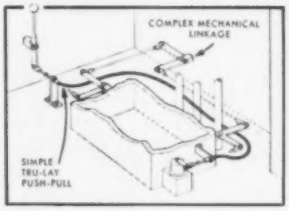

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It is the result of a literature search in the field of heat transfer intended to uncover basic principles effecting cooling of small, lightweight, vehicular engines. Author lists over 200 publications and gives a resume of each reference which relates to cooling of small engines.

Fluid Pressure Mechanisms

H. G. CONWAY. *Published by Pitman Publishing Corp., 2 W. 45th St., New York City.* 5½ x 9, 240 *pp*, $6.75.

This comprehensive work deals with the mechanism of fluid pressure equipment. Essential principles of various devices in hydraulic and pneumatic machinery are covered; detailed design features of equipment are not included. Hydraulic, pneumatic and compressed gas systems of high, medium and sometimes low pressure are also covered. Clear, diagrammatic illustrations are generously dispersed throughout the text.

High-speed Data Processing

C. C. GOTLIEB and J. N. P. HUME, published by McGraw-Hill Book Co., 330 W. 42nd St., New York 36. 9¼x6¼, 338 *pp*, $9.50.

The book does not limit itself to any particular machine, but covers data processors of all types from all manufacturers. Outlined are principles and general techniques of processing data at high speeds, particularly for business purposes. Included is a detailed study of coding and programming, with special emphasis placed on the importance of flow charts in the analysis of problems.

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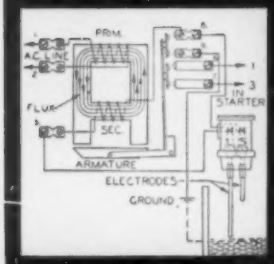

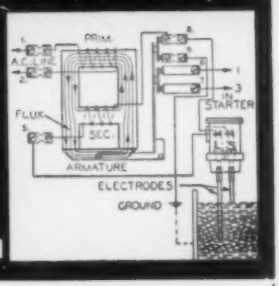

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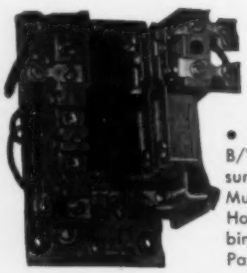

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Circle E 32

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Circle E 31

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Sandwich-panel Adhesives
The 14 most widely specified adhesives, with comparison table. May 26, '58, p. 56.
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Coriolis Acceleration
Describes with equations how this force affects various components. May 26, '58, p. 72. Circle No. E 25

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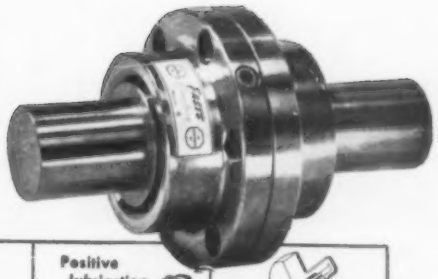

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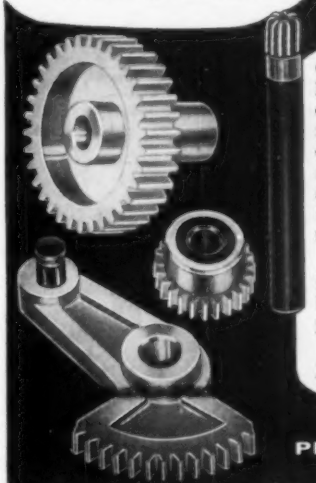

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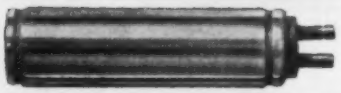

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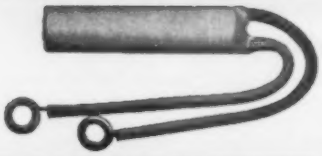

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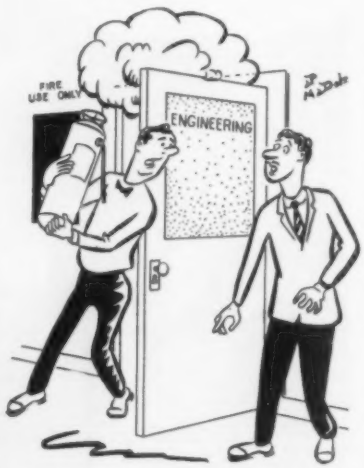

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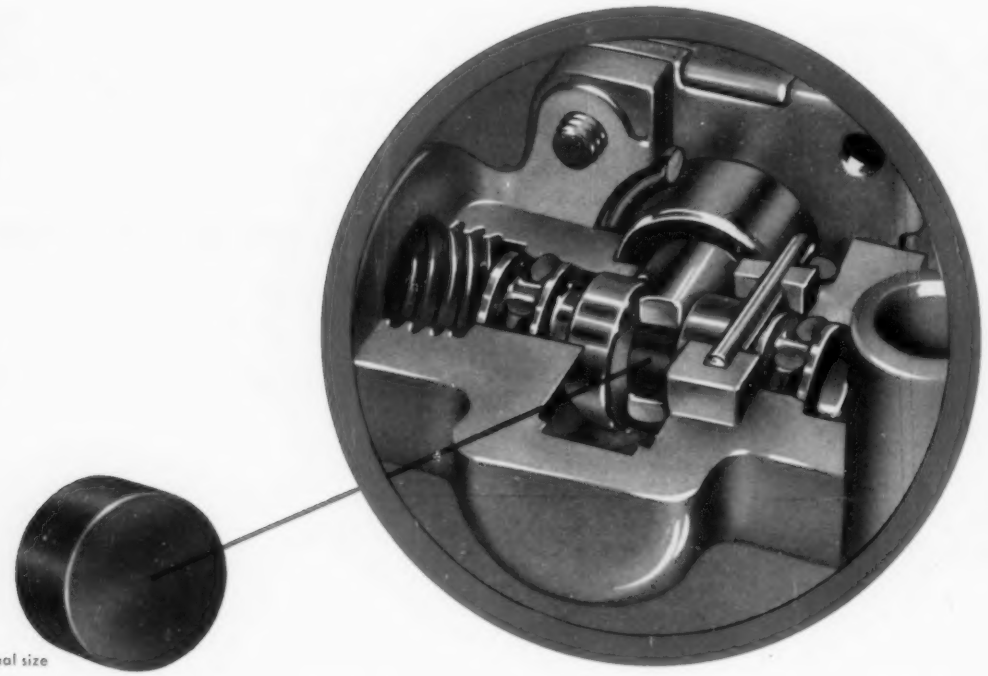

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